DOCUMENT RESUME

ED 063 465 VT 015 229

TITLE	Industrial Prep, Volume Three, Junior Year--Contents: Physics and English.
INSTITUTION	Hackensack Public Schools, N.J.
REPORT NO	CVTE-E-8
NOTE	396p.; PAES Collection
EDRS PRICE	MF-$0.65 HC-$13.16
DESCRIPTORS	Audiovisual Aids; Behavioral Objectives; Bibliographies; *Career Education; Curriculum Guides; Developmental Programs; *English Curriculum; Grade 11; Instructional Aids; *Interdisciplinary Approach; Occupational Guidance; *Physics Curriculum; Project Training Methods; Self Concept; Student Projects; *Teaching Guides; Teaching Procedures; Vocational Education; Worksheets
IDENTIFIERS	Career Exploration; Economic Awareness

ABSTRACT

This Grade 11 teaching guide contains two curriculums which focus on 10 team physics projects and five thematic units in English. The 10 group physics projects are derived from the application of three laboratory units on the properties of matter, mechanics, and electricity. The outlined English curriculum ranges from such specifically pragmatic topics as work preparation and physics to more broadly applicable units on television, economics, and prejudice, stressing relevance to the needs and interests of vocational students. The extensive economics unit deals with consumer credit and buying used cars. The unit on prejudice outlines the causes and effects of social discrimination, provides literary illustrations with suggested projects and a bibliography, and discusses prejudice in mass media. Multimedia resources and ideas for the guide include project lists, discussion questions, visual aids, and student reading materials. Procedures for implementing goals include use of student worksheets for each physics lesson, a student evaluation sheet, term definitions, and detailed daily lesson plans in outline form. Developed by a group of educators from Hackensack High School, New Jersey, this is the third volume in a comprehensive 3-year interdisciplinary program in industrial preparation for vocational students. Others are available as VT 015 227-VT 015 231 in this issue. (AG)

ED 063465

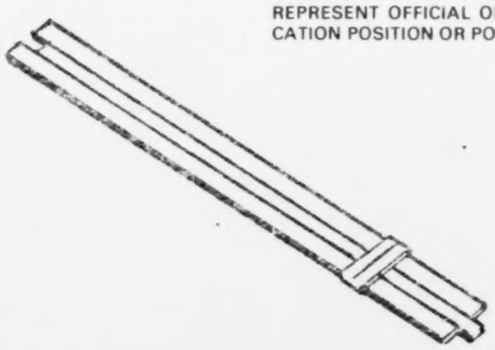
3-8 Bely

INDUSTRIAL PREP

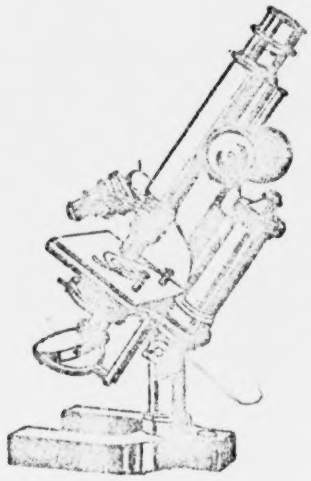
Volume Three

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

FILMED FROM BEST AVAILABLE COPY



HHS



Junior Year

CONTENTS: PHYSICS
ENGLISH

VT015229

"INDUSTRIAL PREP"
VOL. 3 JUNIOR YR.

NOTES - VOLS. 3 & 4 ARE CONTINUOUS

TABLE OF CONTENTS

I. INTRODUCTION

II. PHYSICS – Samples included

III. ENGLISH – Samples included

IV. MATHEMATICS → ARE IN VOL. 4 → Samples included

V. GUIDANCE → " " " " ↗

Introduction

Physics is the guiding subject of the Industrial Prep Junior year. A more technically related science than biology, physics affords students the opportunity of realistically relating industrial theory with practical work experiences. There are ten projects emanating from the physics class that are used for both independent and cooperative research, planning, and development for the students in the course. These problems are designed to utilize both the subject matter and facilities of the correlating disciplines.

Mathematics and physics are almost directly related for most of the school year and both course guides are presented with some detail in the book. English and Guidence collaborate for a series of projects dealing with the individual and his society. The guidance counselor's role is one of supplementing, through gained personal insights, the student's awareness of himself in relation to his personal and interpersonal behavior.

The methods of implementing the philosophy of the program remain the same as those of the sophomore year. It continues to be a course that utilizes the practical and visual materials of our society and develops from these the abstract concepts that lead to a comprehensive, flexible educational background.

Because good work attitudes are essential goals of the Industrial Prep program a specific evaluation sheet has been developed. It's purpose is to keep the student, his teachers, and parents aware of his behavior throughout the school year. This information is considered to be of prime importance in the guidance of the student through the curriculum and for job placement in the school's cooperative program and after graduation.

INDUSTRIAL PREP WORK ATTITUDES RATINGS

NAME ____________________ CLASS ____________________ DATE ____________

Trait						
Initiative						
Industry						
Dependability						
Willingness to work						
Cooperation with instructor						
Cooperation with fellow students						
Precision and accuracy						
Attendance and punctuality						

Comments:

E = Excellent G = Good P = Poor

VG = Very Good F = Fair VP = Very Poor

Parent's / Guardian's signature

____

PARENT'S COMMENTS :

Student's signature

____

INDUSTRIAL PREP PHYSICS

Table of Contents

Unit 1

Lessons 6
Labs 41

Unit 2

Lessons 66
Labs 123

Unit 3

Lessons 141
Labs 200
Projects 207

Industrial Prep Physics

Physics is being used as the key subject in the Industrial Prep junior year. It has been selected as the leading area of study because of its significant contribution to the development and operation of the products of our industrial society. The Industrial Prep Physics course attempts to provide students with an appreciation of many of the concepts and fundamental technical principles utilized in the work world. Material is structured for the students in the program so that the scientific understanding from the physics viewpoint on the how and why of industrial processes become part of their general knowledge. Besides the importance of assimilating the technical fundamentals in the area, students are given experiences in developing an orderly approach to problem solving. A disciplined method of thinking is promoted in the youngsters which will enable them to better organize their methods of researching, analyzing, and overcoming problems.

The work is being presented in three units; properties of matter, mechanics, and electricity. With the fundamental background in the characteristics of matter an Industrial Prep student should have a more curiosity filled realization of his world. A condition of asking, "Why are things the way they are?", is a prime goal of this unit. The practical aspects of this study deals with the measurement and utilization of various materials.

The mechanics unit is basic to all industrial processes. From experiences gained in this area a student should be able to tackle common problems in the use of tools and equipment.

An appreciation in design, care, and utilization of this equipment is also stressed in class in cooperation with the shop instructors.

Because eledtricity is a prime energy source for most industrial activities it is presented as a lengthy unit in the physics class. Instructional material and lab related experiences provide a background leading to a safe and applicable working knowledge of this field of study. The presented work concerns itself with the weaving of abstract concepts into practical approaches in acquiring an understanding of electricity.

Much of the instruction in Industrial Prep physics provides for student discovery rather than offering a formal, lecture and laboratory presentation. A major portion of the work is conducted by the students in laboratory sessions and team projects. There are ten team projects for the students. They were selected and developed because they provide problem experiences that students can overcome by themselves and also, they enable youngsters the opportunity of being part of a research and development team and thus realize the responsibilities and satisfaction of such work.

1^{st} UNIT

LESSON 1 - Meaning and Importance of Science

1. What common things which we have today were not available fifty years ago?
    - 1.1 Fluorescent lights
    - 1.2 Transistor radios
    - 1.3 Televisions
    - 1.4 Automatic transmissions
    - 1.5 Power brakes and steering
    - 1 6 Jet aircraft
    - 1.7 Long distance direct dialing

2. Science has made possible the development of these things.
    - 2.1 What is science?
        - 2.11 A way of solving a problem.
        - 2.12 A process of gathering, testing and organizing knowledge.

    - 2.2 How does science bring about these advancements? for example - nylon
        - 2.21 From basic scientific study the idea of a strong chemically formed fiber was developed.
        - 2.22 Laboratory experimentation was carried on until a fiber with the desired properties was made.
        - 2.23 A small scale factory was designed and built to produce the fiber.
        - 2.24 Sample products were made from the fiber and presented to potential users.
        - 2.25 When the production problems had been solved and a market for the fiber established then a full scale plant was built and the material became generally available.
        - 2.26 Continuous study is made for better production processes and for additional uses of the product.

3. Assignment - Cover textbook and become familiar with the location and content of the general aids in the text: i.e., glossary, table of contents, index and appendix.

LESSON 2 - Divisions of Science and Scientific Method

1. Quiz on the use of the book.

2. Areas of science
    - 2.1 Very hard to set up rigid lines of division due to overlap of areas.

Name__________________________________ Date_____

Quiz on Use of Book.

Write down the page numbers where you could find the following information.

1. Definition of wavelength 1. ....
2. Location of information on infrared waves. 2. ....
3. Page number for chapter on Magnitism. 3. ....
4. Commision tables for English and Metric units of measure. 4. ....
5. Location of information about mirages. 5. ....
6. Purpose and general information about the book. 6. ....
7. Page number for section on Basic properties of Gases. 7. ....
8. Definition of dispusion 8. ....
9. Physical properties of pure metals. 9. ....
10. Location of an experiment on convex lenses. 10. ....

2.2 Basic division - living and non-living
2.21 Living - Biological
2.211 Botany - plant life.
2.212 Zoology - animal life.

2.22 Non-living - Physical
2.221 Physics - matter and energy.
2.222 Chemistry - composition of matter.
2.223 Astronomy - sun, moon, stars and planets.
2.224 Meteorology - weather.
2.225 Geology - earth.
2.226 Metallurgy - composition and structure of metals.

3. What is physics?
3.1 Situations where principles of physics are used.
3.11 Passengers in a car being thrown to the side on a curve.
3.12 Using mats on the floor in the gymnasium.
3.13 Using aids to lift heavy loads.
3.14 Grounding electrical tools when used outside.

3.2 Definition: Physics is the study of matter and energy and their interelationship.
3.3 Divisions of Physics - based upon type of energy involved.
3.31 Mechanics
3.32 Heat
3.33 Sound
3.34 Light
3.35 Electricity
3.36 Nuclear physics

4. Scientific Method
4.1 An orderly and logical process for solving a problem.
4.2 Steps involved
4.21 Define problem.
4.22 Gather facts through careful study and experimenting.
4.23 Set up possible solutions based on gathered facts.
4.24 Examine each possible solution and test for validity.
4.25 Elinimate unworkable solutions and test the others again.
4.26 Draw conclusions

5. Assignment - Select some problem you have encountered and use the Scientific Method to solve it.

LESSON 3 - Science of Matter

1. Have several students read their homework assignment and discuss with the class.

2. What is matter?
2.1 Display a number of objects (book, piece of chalk, water, pencil, etc.)
2.2 What do all these objects have in common?
2.21 All take up space
2.22 All have weight

2.3 Definition - Matter is anything which occupies space and has weight.

3. What is the composition of matter?
3.1 Earliest concept - a piece of matter could be divided indefinitely and still retain its characteristics.
3.2 Democritus suggested a limit to the division of matter.
3.21 Proposed the idea of ultimate particles.
3.22 Four types of particles.
Stone, water, air, and fire.

3.3 Molecule
3.31 Smallest unit into which matter can be divided without changing its characteristics.
3.32 Size of molecule
3.321 Very hard to comprehend
3.322 If a drop of water was magnified to the size of the earth, each molecule would be about three feet in diameter.
3.323 Average diameter $3X10^{-8}$cm.

3.4 Properties of matter are dependent upon arrangement of molecules.
3.41 Molecules of any one material are all alike and arranged in a particular manner.
3.42 Molecules of different materials are not alike and are arranged in different manners.
3.421 May be closer together or farther apart.
3.422 May be held more or less tightly.
(Use styrofoam ball models of molecules and crystals to illustrate.)

3.5 Physical Change
3.51 Any change in matter which does not alter the the structure of the molecule.
3.52 Examples - change of state, bending, molding, etc.

4. Assignment - Write up definitions for new terms in definition section of notebook. Study definitions.

LESSON 4 - Basic Properties of Matter

1. Develop concept of a basic property.
1.1 Display a number of various objects--book, pencil, piece of chalk bit of metal, glass objects, mercury, water, etc.

1.2 How are all these objects similar?
1.3 Evolve concept that basic properties are those which all matter have in common.

2. Basic properties
   2.1 Weight - force exerted by gravity on the object.
   2.2 Volume - space occupied by object.
   2.3 Inertia - resistance of the object to a change in motion.
   2.4 Mass - the measurement of the quantity of inertia.
   2.5 Density - comparison of the object's weight to its volume.
   2.6 Impenetrubility - no two objects can occupy the same space at the same time.
   2.7 Porosity - space exists between particles of matter into which other matter can penetrate.
   2.8 Cohesion - attraction of the same kind of molecules for each other.
   2.9 Adhesion - attraction of different kinds of molecules for each other.
   2.10 State of matter
   2.101 Solid state - has a definite size and shape.
   2.102 Liquid state - has a definite size but no definite shape.
   2.103 Gaseous state - has no definite size or shape

3. Assignment - Write definitions of terms in definition section of notebook. Study definitions.

LESSON 5 - Basic Properties of Solids

1. Quiz on terms from lesson 3 and 4.

2. What is a solid?
   2.1 That state of matter which as a definite size or shape.
   2.2 General types of solids.
      2.21 Crystalline
         2.211 Molecules in an orderly arrangement.
         2.212 Metals, ice, diamonds and table salt.

      2.22 Amorphous
         2.221 No orderly arrangement of molecules.
         2.222 Plastics, glass and tar.

3. Properties of solids.
   3.1 Dependent upon the amount of cohesive force.
   3.2 Hardness - ability to resist scratching.
   3.3 Toughness - ability to withstand a permanent change.
   3.4 Malleability - ability to be hammered or rolled into sheets.

3.5 Ductility - ability to be drawn through a die.
3.6 Elasticity - ability to recover from destortion.
3.7 Tenacity - ability to resist pulling apart.
3.8 Machinability - ability to be shaped by cutting tools.
3.9 Fusibility - ability of a material to be joined together by melting
3.10 Conductivity - ability of a material to permit the flow of electrical charge or heat.

4. Assignment - Write up and study definitions of new terms.

LESSON 6 - Properties of Solids--Hardness, Toughness, Malleability and Ductility

1. Review definitions of: Hardness, toughness, malleability and ductility.

2. Hardness
    - 2.1 Importance
        - 2.11 Cutting tools - carbide lathe tools and diamond drills.
        - 2.12 Bearing surfaces - reduce wear.
        - 2.13 Abrasive wheels for cutting and polishing.
    - 2.2 Measuring hardness - use picture projectuals for overhead projecter to illustrate
        - 2.21 Hardness points - a set of samples with known hardness which can be rubbed against the surface to be tested.
        - 2.22 Rockwell Hardness test
            - 2.221 A hard metal point is forced into the surface under a predetermined amount of force.
            - 2.222 The depth of penetration indicates the hardness of the surface.
        - 2.23 Schleroscope Test
            - 2.231 A small hardened metal hammer is dropped from a fixed height upon the surface.
            - 2.232 Height to which hammer bounces is an indication of the hardness.

3. Toughness
    - 3.1 Importance
        - 3.11 Supporting members for buildings need to withstand heavy loads.
        - 3.12 Crankshaft on an automobile engine is subjected to high stresses.
        - 3.13 Many tools require ability to withstand large force--wrenches, screwdrivers, hammers, etc.

- 3.2 Producing toughness
  - 3.21 Laminating wooden building trusses.
  - 3.22 Forging process for making crank shafts and tools.

4. Malleability
   - 4.1 Develops very tough materials.
     - 4.11 Rolling structural steel.
     - 4.12 Forging crankshafts and certain tools.
   - 4.2 Can economically produce various forms from a basic shape.
     - 4.21 "I" beams from rectangular ingots.
     - 4.22 Metal sheets and foils.
     - 4.23 Round and bar stock steel.

5. Ductility
   - 5.1 Drawing
     - 5.11 Process of pulling material through a die.
     - 5.12 Making of wire and seamless pipe.
   - 5.2 Extruding
     - 5.21 Process of pushing material through a die.
     - 5.22 Aluminum and steel moldings.

6. Assignment - For each of the four properties listed in the lesson find three objects in the home which are dependent upon this property.

LESSON 7 - Properties of Solids - Elasticity

1. Check over with the group some of the lists written for homework.

2. Definition of elasticity
   - 2.1 The ability to recover from distortion.
   - 2.2 Stress--force producing the distortion.
   - 2.3 Strain--the distortion which results from the stress.

3. Types of elasticity
   - 3.1 Extension
     - 3.11 The stress causes an increase in length.
     - 3.12 Examples: spring balance, elastic band.
   - 3.2 Compression
     - 3.21 The stress causes a decrease in length or volume.
     - 3.22 Examples: coil springs in a car, springs in a mattress.
   - 3.3 Torsion

3.31 The stress tends to twist the object.
3.32 Example: Torsion bars on automobiles.

3.4 Flexion
  3.41 The stress tends to bend the object.
  3.42 Examples: leaf springs in a car, diving board, watch spring.

4. Elastic limit
  4.1 Illustrate by adding increasing amounts of weight to a spring until it becomes permanently distorted.
  4.2 Definition - The smallest amount of stress which will produce a permanent distortion.

5. Hooke's Law
  5.1 Apply weights to a spring and record the amount it stretches for each weight.
  5.2 Calculate the ratios of the weights to the amount of stretch.
  5.3 Conclusion: Within the elastic limit the ratio of stress to strain is constant.
  5.4 Examples:
    5.41 A force of 6 pounds stretches a spring 18 inches.
    5.42 How far will the spring stretch under a force of 2 pounds.
    5.43 Solution:

$$\frac{6\text{ lb.}}{18\text{in.}} = \frac{2\text{ lb.}}{S\text{ in.}}$$

$$S = \frac{18\text{ in. X } 2\text{ lb.}}{6\text{ lb.}}$$

$$S = 6\text{ in.}$$

    5.44 How much force is needed to stretch it 15 inches?
    5.45 Solution:

$$\frac{6\text{ lb.}}{18\text{ in.}} = \frac{F}{15\text{ in.}}$$

$$F = \frac{6\text{ lb. X } 15\text{ in.}}{18\text{ in.}}$$

$$F = 5\text{ lb.}$$

6. Assignment - Worksheet on elasticity.

LESSON 8 - Properties of Solids - Tenacity

1. Check over worksheet assignment on elasticity.

"INDUSTRIAL PREP"
VOL. 3 JUNIOR YR.

INDUSTRIAL PREP ENGLISH

JUNIOR YEAR

Industrial Prep English - Junior Year

The Desires and Needs of Students is the Number One Consideration for Any Curriculum Change.

The past two years in Industrial Prep English has shown that a curriculum that does not specifically take into account the desires and needs of the students for whom it is intended, cannot be successful. It is evident that students in this course learn only when they see the need and feel a desire for learning.

The Industrial Prep English Curriculum in the Junior Year attempts to start from this point and establishes a program built around the student.

The purpose is not to fit the student into a desired mold, but rather to enable each boy to develop his own abilities and interests as he sees fit within the broad framework of an English course. Instead of attempting to change the boy, the philosophy is to revise the curriculum and school environment so that the student may naturally develop and take his proper place in the world.

Though doubts may be cast as to the reality of such a program, a journey most commence with one step and this English Curriculum is that initial step.

The Automobile and Television Can Probably Teach the [illegible]

In the preceding year it was clearly recognized that the number one interest of the Industrial Prep boys was cars. Because of this fondness the teaching of any number of traditional concepts, even with an excellent and stimulating teacher, made little or no conceivable impression because the students simply did not wish to learn that which they couldnot see as useful. Consequently a curriculum that wishes to be successful must take this car-mania into consideration.

A significant observed point was that as the boys matured their interest in the automobile industry as a means of earning a living waned. As the boys approached seventeen their major interest in life no longer was cars though their desire for an automobile increased. The car was no longer desired for itself, but as a symbol of independence, power, and sex.

Based on these drives the boys took after school jobs to earn enough money to buy and support their cars and this opened any number of ancillary fields which the curriculum planner took advantage of, i.e. taxation, installment buying, insurance, future jobs and laws.

Another interest of the boys was television. This was not the television that their teachers watched, but the shows that many adults would term foolish. Television was a favorite pastime for the boys because it was free, near, convenient and a "cool medium." They watched it not to be motivated, challenged or inspired, but to relax, dream and be amused.

[illegible] and Content of English Remains the Same, [illegible] Approach Is [illegible].

Because of the preceding observations the purpose of the Industrial Prep English program has not necessarily changed from last year. The avowed purpose remains to teach Industrial Prep students how to read, write, speak, listen and think with as much discernment and discrimination as possible, so that they will be able to adequately function in society.

What is changed from last year is the approach to achieving these goals. Originally it was thought that the broad eight areas of English, reading, literature, and composition, mass media, critical thinking, speech, listening and linguistics, would appeal to the student given an intelligent, interesting teacher who chose appropriate illustrations from each area.

In most cases the program proved successful. Basically the boys were willing to respond if the particular area under discussion was one that they felt filled a present active need, i.e, reading the help wanted ads & evaluating car advertisements.

Consequently the current approach is to use the content of the eight areas as a guide, and to search for unit topics for the students that will:

1. take into consideration their interests
2. fulfill their present and future needs
3. be sufficiently pragmatic to them
4. place more of a physical burden on the individual
5. broaden their horizons
6. continue to act as a forum for divergent points of view

7. correlate material with the rest of the Industrial Prep program
8. keep the philosophy of the Industrial Prep program in mind

In each of the units, some of the eight areas of the Hackensack High School English Curriculum are present, and in the complete Junior Year program all of the eight areas are included.

A Unit Approach is Suggested

The Junior Year is divided into five units which will provide sufficient material for the academic year.

Potentially the most far reaching unit is the one on Work Preparation. Here the boys will not only read about future jobs and hear speeches from the work field, but they will correspond with people requesting information, go outside the school to interview people and eventually spend one day "on-the-job" in the field of their choice.

Since the students spend much time with their television sets, the unit on Television provides for an analysis of the medium considering its effects on people, viewing it for more enjoyment and understanding and finally establishing criteria for evaluating shows. The practical part of this unit will be the preparation of a television commercial by the students.

In another unit an attempt is made to correlate English and Physics based upon the Physics Testing Project. The English contribution to this unit will be to have students explain their projects in written and oral work and to relate them actually to industry. To do this means that the boys will search for companies that use their models for actual testing procedures. Finally the boys will visit the companies and see the practical application to their project.

The Economics unit is an extention of the curious attention that students show in a study of the stock market in the Sophomore Year. For the Junior Year the topic of consumer credit revolves around the boys' desires to buy cars. This unit will correlate with the mathematics class where the computations involved in consumer credit will be taught while the English teacher presents such elements as car selecting, and arranging for and maintaining payments.

Finally a unit that takes advantage of the current issues of prejudice will round out the year. The boys, many of whom are Negro, will explore the realistic situation of prejudice through literature, psychology and practical experience. The classroom will provide a sounding board for the boys on many of today's racial issues.

These units are an attempt to further improve the teaching of English for non-college bound students and to establish a practical Industrial Prep Curriculum in Hackensack High School. Just as more insight was gained by the practical application of this curriculum in the Sophomore Year, so it is expected that increased knowledge will be gained as a result of applying this curriculum to the Junior Year.

Industrial Prep English

Junior Year

TABLE OF CONTENTS

I. Unit One - Work Preparation - P. 7
II. Unit Two - Television -- P. 30
III. Unit Three - Physics -- P. 42
IV. Unit Four - Economics -- P. 57
V. Unit Five - Prejudice -- P. 99

"INDUSTRIAL PREP" VOL. 4
JUNIOR YEAR

INDUSTRIAL PREP MATHEMATICS II

Industrial Prep Mathematics II has been developed to extend the student's knowledge of those topics in mathematics which are fundamental for further technical study. The Industrial Prep Mathematics II course has dropped the lead role used by the first-year course. During the junior year Industrial Prep Mathematics II plays a supporting role for Industrial Prep Physics. It also plays a minor role in supporting the Industrial Prep English Teacher during that course's study of borrowing money for the purchase of a car.

The major topics studied in Industrial Prep Mathematics II are: Introduction to Algebra, Introduction to Vectors, Introduction to Simple Machines, and Introduction to Electricity. In each topic, the teacher stresses those fundamentals of mathematics which will be used by the Industrial Prep Physics teacher. The mathematics instructor also stresses those types of calculation and manipulative skills which help improve the students' capability in their study of physics.

The approach is much the same as that used in the sophomore year. A daily presentation is accompanied by classwork and homework assignments and tests.

Introduction to Algebra

Lesson 1

I. Introduction to the slide rule.

- A. Each student receives a twelve-inch slide rule.
  - 1. Teacher, using demonstration slide rule:
    - a. Identifies parts: body, slide, hairline-indicator.
    - b. Explains care of slide rule.
    - c. Purpose of slide rule.
- B. Teacher demonstrates scale markings on C and D scales.
  - 1. Use demonstration rule with all scales covered except for C and D scales.
  - 2. Note that scale markings on C and D scales are the same.
  - 3. Explain that scale markings represent numbers from 1 to 10.
- C. Demonstrate process of multiplication of integers.
  - 1. Have C and D scale markings covered by masking tape except for unit and half-unit markings.
    - a. Left end of C scale over first factor (on scale.)
    - b. Read scale for second factor on C scale.
    - c. Read corresponding mark on D scale as the product.
  - 2. Stress that each setting on slide rule indicates many multiplication problems of numbers having the same digits as the given problem, but different in size.
- D. Demonstrate division using the C and D scale
  - 1. Using a divisor of 2, show that one setting of slide indicates many division problems as well as the related multiplication problems.
- E. Classwork:
  - 1. Students practice estimation of products and quotients.
  - 2. Students practice reading C and D scales for all units and half-units.
  - 3. Students try multiplication problems on slide rule and compare settings with those on demonstration rule.

II. Assignment: Multiplication and division of multiples of (.5) including numbers other than those between 1 and 10.

Classwork and Assignment

1. Write your estimate of the size of each product.
2. Practice using the slide rule to calulate each product.
3. Write the product.

		Estimate	Product
1.	2.5 x 2.5		
2.	1.5 x 3.0		
3.	4.0 x 1.5		
4.	4.5 x 1.5		
5.	6.0 x 1.5		
6.	5.5 x 1.5		
7.	3.0 x 2.5		
8.	2.5 x 3.5		
9.	5.0 x 1.5		
10.	6.0 x .5		

1. Write your estimate of the size of each quotient.
2. Practice using the slide rule to calulate each quotient.
3. Write the quotient.

		ESTIMATE	QUOTIENT
1.	9.0 ÷ 3.0		
2.	7.5 ÷ 2.5		
3.	5.0 ÷ 2.5		
4.	6.0 ÷ 1.5		
5.	7.0 ÷ 3.5		
6.	8.0 ÷ .2		
7.	9.0 ÷ 1.5		
8.	3.0 ÷ .5		
9.	4.5 ÷ .5		
10.	5.0 ÷ 4.0		

INTRODUCTION TO VECTORS

Lesson 1

I. Vectors/direction

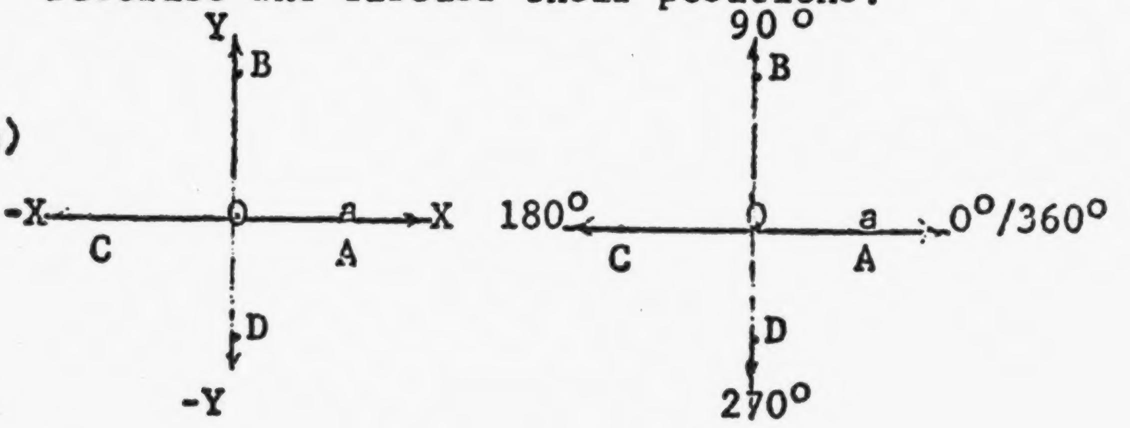
A. Review Ray
   1. Examples of rays.
   2. Definition of rays.
   3. Symbol used to designate rays.
   4. A ——— B → written as $\overrightarrow{AB}$.

      and B ——— A → written as $\overrightarrow{BA}$.
      a. Stress order of reading.

      b. Note: $\overrightarrow{AB} \neq \overrightarrow{BA}$

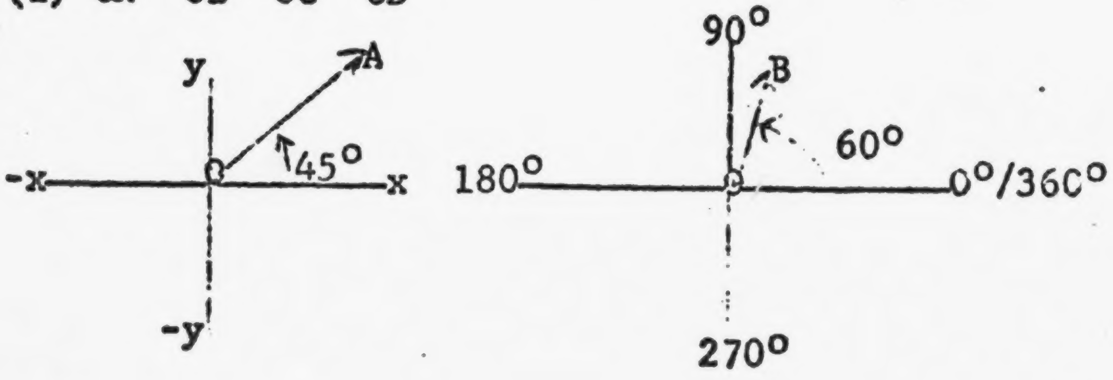
B. Develop concept of a vector.
   1. On coordinate axes, draw sets of four rays. Describe and discuss their positions.

(a)



(i) $\overrightarrow{OA}$ $\overrightarrow{OB}$ $\overrightarrow{OC}$ $\overrightarrow{OD}$

(b)

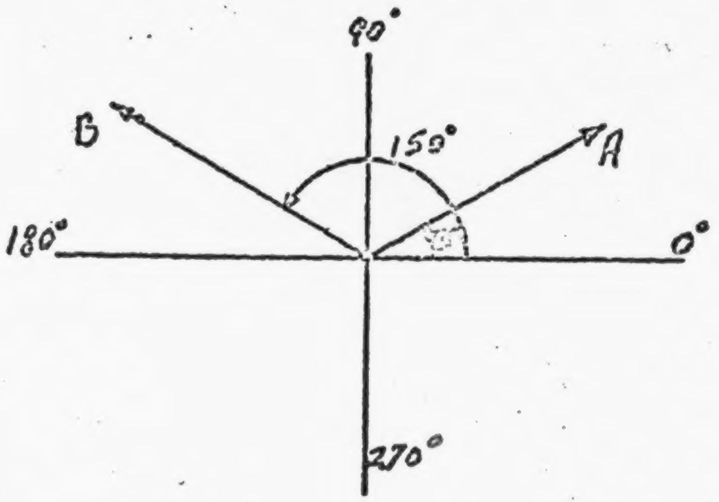


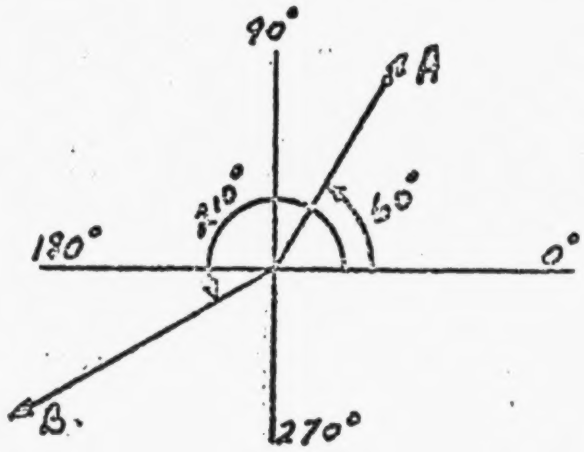
(i) Position of $\overrightarrow{OA}$ and $\overrightarrow{OB}$ determined by angle.
(ii) Ray OA has the origin as its endpoint and is positioned by the 45° angle.
(iii) How is ray OB determined or described?

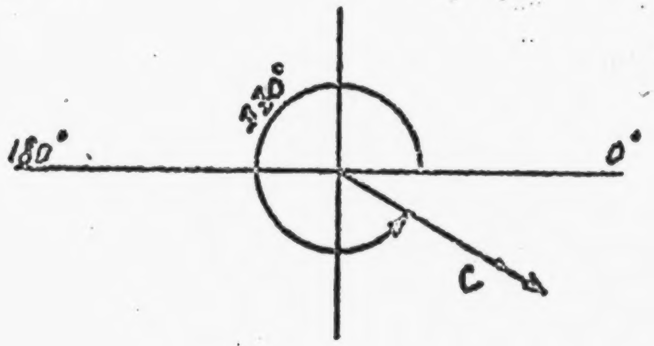
Name ________________________ Date ______________

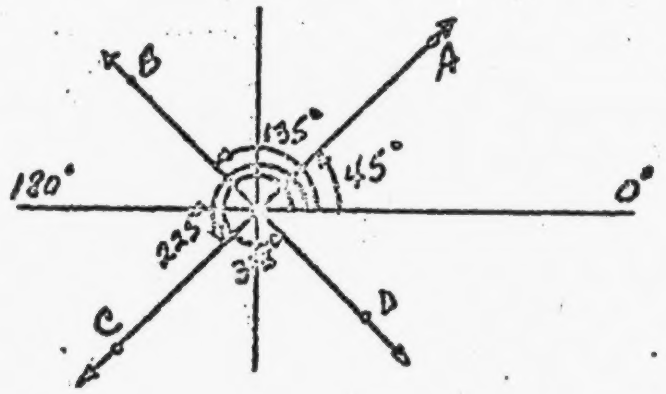
Lesson 1
Classwork and Assignment

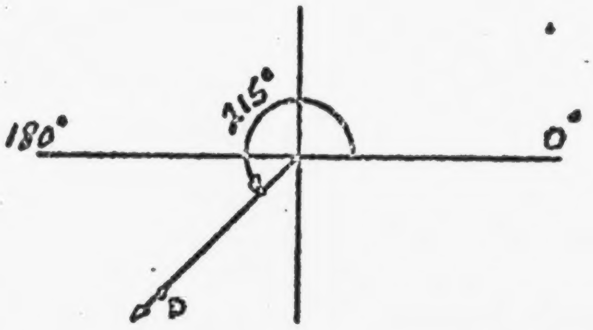
A. Describe the positioning of the rays on each of the following diagrams.

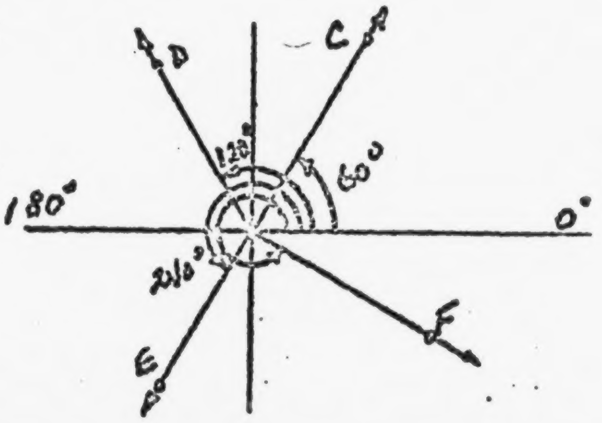

90°
B
150°
A
180°
0°
270°


90°
A
210°
60°
180°
0°
B
270°




B
A
135°
45°
180°
0°
225°
315°
C
D




D
C
120°
60°
180°
0°
240°
E
F

B. Construct each ray on coordinate axes following the description given.

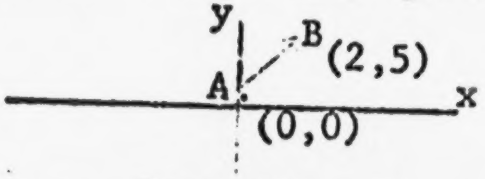
1. OA, endpoint O at the origin and its direction determined by a 20° angle.
2. OB, endpoint O at the origin and its direction determined by an 80° angle.
3. OC, endpoint O at the origin and its direction determined by an angle of 120°.
4. OD, endpoint O at the origin and its direction determined by an angle of 160°.
5. OE, endpoint O at the origin and its direction determined by an angle of 300°.

Lesson 1 (continued)

- C. Classwork: ditto sheet
  - 1. Describe the positioning of the rays on each of the following diagrams.
  - 2. Construct each ray on coordinate axes following the description given.
- D. Assignment
  - 1. Complete ditto sheet according to instructions. (repeat C and D of above.)

Lesson 2

- I. Review homework: Vectors/direction.
  - 1. Identify each ray by name and direction.
- II. Vectors/Magnitude
  - A. Graph the ordered pairs of numbers: A (0,0) and B (3,4)
    - 1. Draw line segment AB.
    - 2. Determine length of line segment AB.
      - i. Distance formula by the pythagorean theorem.
    - 3. Determine angular direction.
      - i. Apply trigonometric functions.
  - B. Vectors
    - 1. Quantities requiring both direction and magnitude.
      - a. The pictorial (graphic) representation of a vector is done in two ways:
        - i. Direction by the direction of the arrow.
        - ii. Magnitude by the length of the arrow.
  - C. Scaler quantities
    - 1. Quantities requiring only magnitude; examples:
      - a. Length of a table.
      - b. Mass of an object.
    - 2. Compare scaler quantities to vector quantities.
  - D. Determine the vector quantity for the given vector:
    - 1.



      - a. Describe vector AB.
      - b. Find length of AB by forming a right triangle.
      - c. Find angular direction by tangent function.
  - E. Classwork: Find the vector quantities for the following vectors (Ditto Sheet)
  - F. Assignment: Complete ditto sheet.

INDUSTRIAL PREPARATORY PROGRAM

JUNIOR YEAR

HACKENSACK HIGH SCHOOL
HACKENSACK, NEW JERSEY

HACKENSACK HIGH SCHOOL
HACKENSACK, NEW JERSEY

INDUSTRIAL PREPARATORY PROGRAM

JUNIOR YEAR

1967

Dr. Donald R. VanWagenen
Superintendent of Schools

Miss Barbara A. Wolf
Assistant Superintendent of Schools

STAFF

Mr. Carl E. Padovano
Principal

Mr. Irving Moskowitz
Committee Chairman

Mr. William Bilin
Mathematics

Mr. Dennis Castell
Guidance

Mr. Arthur Collard
Mathematics

Mr. Joseph Ellis
English

Mr. Howard Fuhrmann
Physics

Mr. Robert Tunnard
Drafting

BOARD OF EDUCATION

Dr. J. John Kristal
President

Mr. Alfred L. Abbitt
Vice-President

Mr. John Sedlack

Mr. Richard C. Thiel

Mrs. Sadye Bean

Miss Elsie Roschlau
Secretary

Acknowledgement is made of the valuable assistance given to the committee in the development of the project by the Vocational Division of the New Jersey State Department of Education.

TABLE OF CONTENTS

I. INTRODUCTION

II. PHYSICS

III. ENGLISH

IV. MATHEMATICS

V. GUIDANCE

Introduction

Physics is the guiding subject of the Industrial Prep Junior year. A more technically related science than biology, physics affords students the opportunity of realistically relating industrial theory with practical work experiences. There are ten projects emanating from the physics class that are used for both independent and cooperative research, planning, and development for the students in the course. These problems are designed to utilize both the subject matter and facilities of the correlating disciplines.

Mathematics and physics are almost directly related for most of the school year and both course guides are presented with some detail in the book. English and Guidence collaborate for a series of projects dealing with the individual and his society. The guidance counselor's role is one of supplementing, through gained personal insights, the student's awareness of himself in relation to his personal and interpersonal behavior.

The methods of implementing the philosophy of the program remain the same as those of the sophomore year. It continues to be a course that utilizes the practical and visual materials of our society and develops from these the abstract concepts that lead to a comprehensive, flexible educational background.

Because good work attitudes are essential goals of the Industrial Prep program a specific evaluation sheet has been developed. It's purpose is to keep the student his teachers, and parents aware of his behavior throughout the school year. This information is considered to be of prime importance in the guidance of the student through the curriculum and for job placement in the school's cooperative program and after graduation.

INDUSTRIAL PREP WORK ATTITUDES RATINGS

NAME ______________________ CLASS ______________ DATE __________

Trait							Comments:
Initiative							
Industry							
Dependability							
Willingness to work							
Cooperation with instructor							
Cooperation with fellow students							
Precision and accuracy							
Attendance and punctuality							

E = Excellent   G = Good   P = Poor

VG = Very Good   F = Fair   VP = Very Poor

PARENT'S COMMENTS :

Parent's / Guardian's signature

____

Student's signature

____

INDUSTRIAL PREP PHYSICS

Table of Contents

Unit 1

Lessons 6
Labs 41

Unit 2

Lessons 66
Labs 123

Unit 3

Lessons 141
Labs 200

Projects 207

Industrial Prep Physics

Physics is being used as the key subject in the Industrial Prep junior year. It has been selected as the leading area of study because of its significant contribution to the development and operation of the products of our industrial society. The Industrial Prep Physics course attempts to provide students with an appreciation of many of the concepts and fundamental technical principles utilized in the work world. Material is structured for the students in the program so that the scientific understanding from the physics viewpoint on the how and why of industrial processes become part of their general knowledge. Besides the importance of assimilating the technical fundamentals in the area, students are given experiences in developing an orderly approach to problem solving. A disciplined method of thinking is promoted in the youngsters which will enable them to better organize their methods of researching, analyzing, and overcoming problems.

The work is being presented in three units; properties of matter, mechanics, and electricity. With the fundamental background in the characteristics of matter an Industrial Prep student should have a more curiosity filled realization of his world. A condition of asking, "Why are things the way they are?", is a prime goal of this unit. The practical aspects of this study deals with the measurement and utilization of various materials.

The mechanics unit is basic to all industrial processes. From experiences gained in this area a student should be able to tackle common problems in the use of tools and equipment.

An appreciation in design, care, and utilization of this equipment is also stressed in class in cooperation with the shop instructors.

Because electricity is a prime energy source for most industrial activities it is presented as a lengthy unit in the physics class. Instructional material and lab related experiences provide a background leading to a safe and applicable working knowledge of this field of study. The presented work concerns itself with the weaving of abstract concepts into practical approaches in acquiring an understanding of electricity.

Much of the instruction in Industrial Prep physics provides for student discovery rather than offering a formal, lecture and laboratory presentation. A major portion of the work is conducted by the students in laboratory sessions and team projects. There are ten team projects for the students. They were selected and developed because they provide problem experiences that students can overcome by themselves and also, they enable youngsters the opportunity of being part of a research and development team and thus realize the responsibilities and satisfaction of such work.

1^{st} UNIT

LESSON 1 - Meaning and Importance of Science

1. What common things which we have today were not available fifty years ago?
    - 1.1 Fluorescent lights
    - 1.2 Transistor radios
    - 1.3 Televisions
    - 1.4 Automatic transmissions
    - 1.5 Power brakes and steering
    - 1.6 Jet aircraft
    - 1.7 Long distance direct dialing

2. Science has made possible the development of these things.
    - 2.1 What is science?
        - 2.11 A way of solving a problem.
        - 2.12 A process of gathering, testing and organizing knowledge.
    - 2.2 How does science bring about these advancements? for example - nylon
        - 2.21 From basic scientific study the idea of a strong chemically formed fiber was developed.
        - 2.22 Laboratory experimentation was carried on until a fiber with the desired properties was made.
        - 2.23 A small scale factory was designed and built to produce the fiber.
        - 2.24 Sample products were made from the fiber and presented to potential users.
        - 2.25 When the production problems had been solved and a market for the fiber established then a full scale plant was built and the material became generally available.
        - 2.26 Continuous study is made for better production processes and for additional uses of the product.

3. Assignment - Cover textbook and become familiar with the location and content of the general aids in the text: i.e., glossary, table of contents, index and appendix.

LESSON 2 - Divisions of Science and Scientific Method

1. Quiz on the use of the book.

2. Areas of science
    - 2.1 Very hard to set up rigid lines of division due to overlap of areas.

Name________________________________ Date_____

Quiz on Use of Book.

Write down the page numbers where you could find the following information.

1. Definition of wavelength 1. ....

2. Location of information on infrared waves. 2. ....

3. Page number for chapter on Magnitism. 3. ....

4. Commision tables for English and Metric units of measure. 4. ....

5. Location of information about mirages. 5. ....

6. Purpose and general information about the book. 6. ....

7. Page number for section on Basic properties of Gases. 7. ....

8. Definition of dispersion 8. ....

9. Physical properties of pure metals. 9. ....

10. Location of an experiment on convex lenses. 10. ....

2.2 Basic division - living and non-living
2.21 Living - Biological
2.211 Botany - plant life.
2.212 Zoology - animal life.

2.22 Non-living - Physical
2.221 Physics - matter and energy.
2.222 Chemistry - composition of matter.
2.223 Astronomy - sun, moon, stars and planets.
2.224 Meteorology - weather.
2.225 Geology - earth.
2.226 Metallurgy - composition and structure of metals.

3. What is physics?
3.1 Situations where principles of physics are used.
3.11 Passengers in a car being thrown to the side on a curve.
3.12 Using mats on the floor in the gymnasium.
3.13 Using aids to lift heavy loads.
3.14 Grounding electrical tools when used outside.

3.2 Definition: Physics is the study of matter and energy and their interelationship.
3.3 Divisions of Physics - based upon type of energy involved.
3.31 Mechanics
3.32 Heat
3.33 Sound
3.34 Light
3.35 Electricity
3.36 Nuclear physics

4. Scientific Method
4.1 An orderly and logical process for solving a problem.
4.2 Steps involved
4.21 Define problem.
4.22 Gather facts through careful study and experimenting.
4.23 Set up possible solutions based on gathered facts.
4.24 Examine each possible solution and test for validity.
4.25 Eliminate unworkable solutions and test the others again.
4.26 Draw conclusions

5. Assignment - Select some problem you have encountered and use the Scientific Method to solve it.

LESSON 3 - Science of Matter

1. Have several students read their homework assignment and discuss with the class.

2. What is matter?
2.1 Display a number of objects (book, piece of chalk, water, pencil, etc.)
2.2 What do all these objects have in common?
2.21 All take up space
2.22 All have weight

2.3 Definition - Matter is anything which occupies space and has weight.

3. What is the composition of matter?
3.1 Earliest concept - a piece of matter could be divided indefinitely and still retain its characteristics.
3.2 Democritus suggested a limit to the division of matter.
3.21 Proposed the idea of ultimate particles.
3.22 Four types of particles.
Stone, water, air, and fire.

3.3 Molecule
3.31 Smallest unit into which matter can be divided without changing its characteristics.
3.32 Size of molecule
3.321 Very hard to comprehend
3.322 If a drop of water was magnified to the size of the earth, each molecule would be about three feet in diameter.
3.323 Average diameter $3X10^{-8}$cm.

3.4 Properties of matter are dependent upon arrangement of molecules.
3.41 Molecules of any one material are all alike and arranged in a particular manner.
3.42 Molecules of different materials are not alike and are arranged in different manners.
3.421 May be closer together or farther apart.
3.422 May be held more or less tightly.
(Use styrofoam ball models of molecules and crystals to illustrate.)

3.5 Physical Change
3.51 Any change in matter which does not alter the the structure of the molecule.
3.52 Examples - change of state, bending, molding, etc.

4. Assignment - Write up definitions for new terms in definition section of notebook. Study definitions.

LESSON 4 - Basic Properties of Matter

1. Develop concept of a basic property.
1.1 Display a number of various objects--book, pencil, piece of chalk bit of metal, glass objects, mercury, water, etc.

1.2 How are all these objects similar?
1.3 Evolve concept that basic properties are those which all matter have in common.

2. Basic properties
2.1 Weight - force exerted by gravity on the object.
2.2 Volume - space occupied by object.
2.3 Inertia - resistance of the object to a change in motion.
2.4 Mass - the measurement of the quantity of inertia.
2.5 Density - comparison of the object's weight to its volume.
2.6 Impenetrubility - no two objects can occupy the same space at the same time.
2.7 Porosity - space exists between particles of matter into which other matter can penetrate.
2.8 Cohesion - attraction of the same kind of molecules for each other.
2.9 Adhesion - attraction of different kinds of molecules for each other.
2.10 State of matter
2.101 Solid state - has a definite size and shape.
2.102 Liquid state - has a definite size but no definite shape.
2.103 Gaseous state - has no definite size or shape

3. Assignment - Write definitions of terms in definition section of notebook. Study definitions.

LESSON 5 - Basic Properties of Solids

1. Quiz on terms from lesson 3 and 4.

2. What is a solid?
2.1 That state of matter which as a definite size or shape.
2.2 General types of solids.
2.21 Crystalline
2.211 Molecules in an orderly arrangement.
2.212 Metals, ice, diamonds and table salt.

2.22 Amorphous
2.221 No orderly arrangement of molecules.
2.222 Plastics, glass and tar.

3. Properties of solids.
3.1 Dependent upon the amount of cohesive force.
3.2 Hardness - ability to resist scratching.
3.3 Toughness - ability to withstand a permanent change.
3.4 Malleability - ability to be hammered or rolled into sheets.

3.5 Ductility - ability to be drawn through a die.
3.6 Elasticity - ability to recover from destortion.
3.7 Tenacity - ability to resist pulling apart.
3.8 Machinability - ability to be shaped by cutting tools.
3.9 Fusibility - ability of a material to be joined together by melting
3.10 Conductivity - ability of a material to permit the flow of electrical charge or heat.

4. Assignment - Write up and study definitions of new terms.

LESSON 6 - Properties of Solids--Hardness, Toughness, Malleability and Ductility

1. Review definitions of: Hardness, toughness, malleability and ductility.

2. Hardness
2.1 Importance
2.11 Cutting tools - carbide lathe tools and diamond drills.
2.12 Bearing surfaces - reduce wear.
2.13 Abrasive wheels for cutting and polishing.

2.2 Measuring hardness - use picture projectuals for overhead projecter to illustrate
2.21 Hardness points - a set of samples with known hardness which can be rubbed against the surface to be tested.
2.22 Rockwell Hardness test
2.221 A hard metal point is forced into the surface under a predetermined amount of force.
2.222 The depth of penetration indicates the hardness of the surface.

2.23 Schleroscope Test
2.231 A small hardened metal hammer is dropped from a fixed height upon the surface.
2.232 Height to which hammer bounces is an indication of the hardness.

3. Toughness
3.1 Importance
3.11 Supporting members for buildings need to withstand heavy loads.
3.12 Crankshaft on an automobile engine is subjected to high stresses.
3.13 Many tools require ability to withstand large force--wrenches, screwdrivers, hammers, etc.

3.2 Producing toughness
    3.21 Laminating wooden building trusses.
    3.22 Forging process for making crank shafts and tools.

4. Malleability
  4.1 Develops very tough materials.
    4.11 Rolling structural steel.
    4.12 Forging crankshafts and certain tools.

  4.2 Can economically produce various forms from a basic shape.
    4.21 "I" beams from rectangular ingots.
    4.22 Metal sheets and foils.
    4.23 Round and bar stock steel.

5. Ductility
  5.1 Drawing
    5.11 Process of pulling material through a die.
    5.12 Making of wire and seamless pipe.

  5.2 Extruding
    5.21 Process of pushing material through a die.
    5.22 Aluminum and steel moldings.

6. Assignment - For each of the four properties listed in the lesson find three objects in the home which are dependent upon this property.

LESSON 7 - Properties of Solids - Elasticity

1. Check over with the group some of the lists written for homework.

2. Definition of elasticity
  2.1 The ability to recover from distortion.
  2.2 Stress--force producing the distortion.
  2.3 Strain--the distortion which results from the stress.

3. Types of elasticity
  3.1 Extension
    3.11 The stress causes an increase in length.
    3.12 Examples: spring balance, elastic band.

  3.2 Compression
    3.21 The stress causes a decrease in length or volume.
    3.22 Examples: coil springs in a car, springs in a mattress.

  3.3 Torsion

3.31 The stress tends to twist the object.
3.32 Example: Torsion bars on automobiles.

3.4 Flexion
3.41 The stress tends to bend the object.
3.42 Examples: leaf springs in a car, diving board, watch spring.

4. Elastic limit
4.1 Illustrate by adding increasing amounts of weight to a spring until it becomes permanently distorted.
4.2 Definition - The smallest amount of stress which will produce a permanent distortion.

5. Hooke's Law
5.1 Apply weights to a spring and record the amount it stretches for each weight.
5.2 Calculate the ratios of the weights to the amount of stretch.
5.3 Conclusion: Within the elastic limit the ratio of stress to strain is constant.
5.4 Examples:
5.41 A force of 6 pounds stretches a spring 18 inches.
5.42 How far will the spring stretch under a force of 2 pounds.
5.43 Solution:

$$\frac{6\ \text{lb.}}{18\text{in.}} = \frac{2\ \text{lb.}}{S\ \text{in.}}$$

$$S = \frac{18\ \text{in.} \times 2\ \text{lb.}}{6\ \text{lb.}}$$

$$S = 6\ \text{in.}$$

5.44 How much force is needed to stretch it 15 inches?
5.45 Solution:

$$\frac{6\ \text{lb.}}{18\ \text{in.}} = \frac{F}{15\ \text{in.}}$$

$$F = \frac{6\ \text{lb.} \times 15\ \text{in.}}{18\ \text{in.}}$$

$$F = 5\ \text{lb.}$$

6. Assignment - Worksheet on elasticity.

LESSON 8 - Properties of Solids - Tenacity

1. Check over worksheet assignment on elasticity.

Name________________________________ Date______________

I.P. Physics - Worksheet on Elasticity

1. A spring stretches 6.4 inches when a force of 4.0 lb. applied. Find how far the spring will stretch under each of the following forces.

a. 1.0 lb. ....

b. 12.0 lb. ....

c. 5.0 lb. ....

d. 32.0 ounces ....

e. 8.0 lb. ....

f. 24.0 ounces ....

2. A spring stretches 16.0 inches under a force of 8.0 lb. How much force will be needed to produce each of the following stretches?

a. 1.0 units ....

b. 1.0 feet ....

c. 8.0 inches...............

d. 1.5 feet ....

e. 3.0 inches ....

f. 2.5 feet ....

3. When a mass of 1.5 kg is hung on a spring, the spring stretches 45 cm. How far will it stretch when the following masses are hung on it?

a. 500 g. ....

b. 300 g. ....

c. 1.0 kg. ....

d. 750 g. ....

e. 1.2 kg. ....

f. 900 g. ....

4. A 50 ft. sample of nylon rope stretches 3 ft. under a force of 500 lb. How far would the following lengths of the same rope stretch under the same amount of force?

a. 100 ft. ....

b. 75 ft. ....

c. 25 ft. ....

d. 150 ft. ....

e. 125 ft. ....

f. 60 ft. ....

2. Tenacity
2.1 Definition - The ability of a material to withstand stress.
2.2 Types
2.21 Tension
2.22 Compression
2.23 Shear

3. Tension
3.1 The ability to withstand being pulled apart.
3.2 Applications
3.21 Cables supporting a bridge.
3.22 Tow rope.
3.23 Guy wires on T.V. antenna.

3.3 Tensile strength
3.31 Force required per unit area to pull apart a wire or bar of material.
3.32 Formula $\text{T.S.} = \frac{F}{A}$

3.321 T.S. is tensile strength
3.322 F is force required to break the sample.
3.323 A is the cross sectional area of the sample.

3.33 Units for tensile strength.
lb/in^2, dynes/cm^2, newtons/cm^2
3.34 Examples:
3.341 A wire 0.025 in.^2 in area breaks under a force of 750 lb. What is it's tensile strength?

$$\text{T.S.} = \frac{750 \text{ lb.}}{0.025 \text{ in.}^2}$$

$$\text{T.S.} = 30,000 \text{ lb./in.}^2$$

3.342 What force will break a wire 0.015 in.^2 in area if the tensile strength is 250,000 lb./in.^2?

$$250,000 \text{ lb./in.}^2 = \frac{F}{0.015 \text{ in.}^2}$$

$$F = 0.015 \text{ in.}^2 \text{ X } 250,000 \text{ lb./in.}^2$$

$$F = 3,750 \text{ lb.}$$

3.343 A wire with a tensile strength of 750,000 lb./in.^2 breaks under a force of 1,500 lb. What is it's cross sectional area?

$$750,000 \text{ lb./in.}^2 = \frac{1.500 \text{ lb.}}{A}$$

$$A = \frac{1.500 \text{ lb.}}{750,000 \frac{\text{lb.}}{\text{in.}^2}}$$

$$A = 0.002 \text{ in.}^2$$

4. Compression
    4.1 The ability to withstand crushing.
    4.2 Applications
        4.21 A steel column in a building.
        4.22 Concrete piers supporting a bridge.
        4.23 Legs on a chair.

    4.3 Measuring compression
        4.31 Expressed as the unit stress.
            4.311 Ratio of force applied to the area upon which the force is exerted.
            4.312 Formula $C.S. = \frac{F}{A}$

where C.S. = compressional stress
F = force applied
A = area

        4.32 Example:
What is the compressional stress on a column 20 in.^{2} in area if a load of 96,000 lb. is applied to the column?

$$C.S. = \frac{96,000 \text{ lb.}}{20 \text{ in.}^2}$$

$$C.S. = 4,800 \text{ lb./in.}^2$$

5. Shear
    5.1 The ability to withstand separation by sliding apart.
    5.2 Applications - rivits and bolts holding materials together.
    5.3 Measuring shearing stress
        5.31 Force per unit cross sectional area applied to the object.
        5.32 Formula: $S.S. = \frac{F}{A}$

where S.S. = shearing stress
F = force applied
A = cross sectional area

        5.33 Example:
What is the shearing stress on a rivit 1.5 in.^{2} in area if the force applied is 3,000 lb.?

$$S.S. = \frac{3,000 \text{ lb.}}{1.5 \text{ in.}^2}$$

$$S.S. = 2,000 \text{ lb./in.}^2$$

6. Assignment - Work sheet on tenacity.

Name________________________________ Date______________

I.P. Physics - Worksheet on Tenacity

Values for the tensile strength of materials will be found in the sheets of tables in your notebooks.

1. A cable is to be made which will have a breaking strength of 5,000 lb. What should the cross sectional area of the cable be for each of the following materials.

a. Aluminum ....

b. Copper ....

c. Ordinary steel ....

2. If the breaking strength were 8,000 lb., what would the area of each need to be?

a. Aluminum ....

b. Copper ....

c. Ordinary steel ....

3. Find the breaking strength of the following samples of wire.

a. 0.01 in. diameter copper ....

b. 0.01 in. diameter aluminum ....

c. 0.24 in. diameter copper ....

d. 0.24 in. diameter aluminum ....

4. If a load of 150,000 lb. is applied downward on a concrete column, what is the compressional stress if the column has the following cross sectional areas?

a. 100 in.^{2} C.S. = ... lb./in.^{2}

b. 50 in.^{2} C.S. = ... lb./in.^{2}

c. 75 in.^{2} C.S. = ... lb./in.^{2}

d. 2 ft.^{2} C.S. = ... lb./in.^{2}

Worksheet on Tenacity - Page 2

5. If steel has a shear strength of 1,200,000 lb./in.^{2}, what must be the minimum area of a rivet to withstand the fol-
1 lowing stresses?

a. 650,000 lb. A = ... in.^{2}

b. 4.2 tons A = ... in.^{2}

c. 6,000 lb. A = ... in.^{2}

d. 1.4 tons A = ... in.^{2}

LESSON 9 - Properties of Solids--Machinability, Fusability, and Conductivity

1. Go over worksheet on tenacity.

2. Machinability
    2.1 Ease with which a material may be shaped with cutting tools.
    2.2 Depends upon how strong the forces are which hold the molecules of the metal together.
        2.21 In general the harder the material the less it's ability to be machined.
        2.22 Aluminum, which is soft, is easily machined and can be shaped more quickly than steel which is much harder.

    2.3 Applications
        2.31 Lathe operation - determining speed of feed for a given depth of cut.
            Example - speed of feed for a 1/8 inch deep cut.
            Aluminum - 1200 ft./min.
            Brass - 600 ft./min.
            Steel(soft) 300 ft./min.
            Steel(carbon125 ft./min.
        2.32 Drilling - determining drill speed for a particular size hole.
            Example - drill speed for a ¼ inch hole.
            Aluminum - 4585 rpm
            Brass - 4585 rpm
            Steel(soft) - 1375 rpm
            Steel(carbon) - 764 rpm

3. Fusibility
    3.1 Ease with which a material may be joined to another material by melting.
    3.2 Applications
        3.21 Common soldering
            3.211 Materials to be joined are heated but do not melt.
            3.212 Fusing material melts - e.g. (Mixture of lead and tin.)
            3.213 Materials fused - copper, lead, tin, galvanized iron, etc.
            3.214 Used for simple joining with medium strength and for prevention of leaks.

        3.22 Silver soldering
            3.221 Basic process the same as common soldering.
            3.222 Fusing material--silver.
            3.223 Temperature required is higher.
            3.224 Used where greater strength is required and on some materials where common solder won't fuse.

3.23 Brazing
3.231 Basically the same concept as soldering.
3.232 Fusing material--brass.
3.233 Very high temperatures required
3.234 Used for materials where soldering will not hold and where greater strength is required.

3.24 Welding
3.241 Materials to be joined and the fusing material are both melted.
3.242 Fusing material is generally the same as the materials being joined.
3.243 Very high temperatures are required.
3.244 Produces the strongest type of connection between the pieces.

4. Conductivity
4.1 The ease with which a material will pass electric charge or heat.
4.2 Depends upon:
4.21 The number of easily moved electrons
4.211 Metals are best.
4.212 Non metals are generally the poorest.

4.22 The higher the temperature, the poorer the conductivity.

5. Assignment - Study for test on general properties of matter and properties of solids.

LESSON 10 - Introduction to Liquids

1. Compare a liquid to a solid.
1.1 How are they similar?
1.11 Both have weight.
1.12 Both maintain a constant volume.

1.2 How are they different?
1.21 Solid can stand by itself.
1.22 Liquid needs a container to hold it.

2. Definition of a liquid - that form of matter which has a definite size but no definite shape.

3. Cohesion of liquids
3.1 The property responsible for holding the liquid particles together.

- 3.2 Illustrate cohesion of water by:
  - 3.21 Measuring the force needed to pull a flat glass plate off the surface of water.
  - 3.22 Water hammer
    - 3.221 A sealed glass tube half full of water with most of the air removed from the rest of the tube.
    - 3.222 Water strikes the bottom of the tube with a loud, sharp sound.
    - 3.223 Since there is no air to hold it back the water drops as a whole unit thus the loud noise.

4. Adhesion of liquids
   - 4.1 A finger placed in water has some stuck to it when it is removed.
   - 4.2 The attraction between molecules of water and those of the finger is greater than the water molecules for each other.
   - 4.3 Process is called "wetting."
   - 4.4 Frequently the degree of wetting needs to be increased.
     - 4.41 Grease and oil are not wetted by water.
     - 4.42 A wetting agent such as detergent or soap when added to the water will increase its wetting ability.

5. Surface tension
   - 5.1 Float a razor blade on water.
   - 5.2 Examine the shape of droplets of water and mercury.
   - 5.3 Cohesive forces are trying to pull the surface molecules into the liquid.
   - 5.4 Causes the surface to act like a stretched elastic film.
     - 5.41 Extra force is required to break through the surface.
     - 5.42 Causes free liquids to assume spherical shape as the sphere has the largest volume with the smallest surface area.

6. Capillary action
   - 6.1 Make a capillary tube by heating the middle of a short piece of glass tubing until soft then pulling it out into a long thin tube.
   - 6.2 Insert a piece of the tube into colored water and observe the height to which water rises.
   - 6.3 Insert a piece of glass tubing into mercury and observe the depression of the liquid level.
   - 6.4 Evolve definition of capillary action - the elevation or depression of liquids in small diameter tubes.
     - 6.41 Elevation occurs when liquid wets the tube.
     - 6.42 Depression occurs when liquid does not wet tube.
     - 6.43 The smaller the diameter the greater the elevation or depression.

6.5 Applications
    6.51 Blotting paper and towels.
    6.52 Drawing blood samples for blood tests.
    6.53 Watering house plants from the bottom.
    6.54 Wicks in camping lanterns and stoves.

7. Assignment - Write up definitions for new terms in note book. Study the definitions.

LESSON 11 - Liquids - Viscosity Buoyancy

1. Quiz on terms developed in Lesson 10.

2. Viscosity
    2.1 Pour out into beakers different liquids,
        2.11 water, oil, glycerin
        2.12 compare rate at which each flows

    2.2 Drop small steel balls into each liquid and compare the rate of fall in each.
    2.3 Evolve concept that viscosity is a measure of the opposition of a liquid to flowing.
    2.4 Application - grading of oils.
        2.41 #10 oil is light and flows easily.
        2.42 #30 oil is heavier and flows less easily.

3. Buoyancy
    3.1 Illustrate buoyancy
        3.11 With a spring balance weigh a piece of metal
        3.12 Weigh it again when the metal is submerged in water.
        3.13 Record the difference in the two weights.
        3.14 Repeat with objects of other sizes and weights.
        3.15 Conclusion to be drawn is that water exerts a force on an object which is dependent not on the weight of the object but on its size.

    3.2 Archimedes' Principle
        3.21 Using an overflow can and catch bucket determine the weight of the water displaced.
        3.22 Compare this weight with the weight loss of the object in the water.
        3.23 Repeat the work using a liquid of different density (alcohol, carbon tetrachloride)
        3.24 Evolve Archimedes' Principle - the buoyant force exerted by a liquid on an object submerged in the liquid is equal to the weight of the liquid displaced.

    3.3 Floating objects
        3.31 If the density of the object is less than that of the liquid then the weight of a volume of liquid equal to the volume of object is greater than the weight of the object.

3.32 The object will float and the amount of liquid displaced will equal the weight of the object, not its volume.

4. Assignment - Worksheet on buoyancy.

LESSON 12 - Liquids--Specific Gravity

1. Review the worksheet on buoyancy.

2. Ways of expressing density.
    2.1 Mass density--g/cm^3, kg/m^3, slugs/ft.^{3}
    2.2 Weight density--lb./ft.^{3}, dynes/cm^3, nt./m^3

3. Problem arises for listing the densities.
    3.1 To set up tables for each way of expression would prove too cumbersome.
    3.2 No one unit of expression is necessarily better than another.

4. A relative type density expression has been developed.
    4.1 All densities are expressed as a multiple of a standard.
        4.11 For solids and liquids standard is water.
        4.12 For gases the standard is air.
    4.2 Called Specific Gravity - the ratio of the density of an object to the density of a standard.
        4.21 Formula: $$\text{Sp. Gr.} = \frac{D_o}{D_s}$$

where Sp. Gr. = specific gravity.
D_o = density of the object.
D_s = density of the standard.

4.22 To work with this concept the various densities of the standard must be known.
For water they are: 1 g/cm^3, 1000 k/m^3.
1.95 slugs/ft.^{3}, 980 dynes/cm^3, 9,800 nt./m^3
and 62.4 lb./ft.^{3}

4.23 Examples:
4.231 What is the specific gravity of an object whose density is 380.4 lb./ft.^{3}?

$$\text{Sp. Gr.} = \frac{380.4 \text{ lb./ft.}^3}{62.4 \text{ lb./ft.}^3}$$

$$\text{Sp. Gr.} = 6$$

Name________________________ Date______

Worksheet on Buoyancy.

Density of water -- 62.4 lb/ft^3, 980 dynes/cm^3, 9800 nt/m^3

1. Complete the following table.

Weight of Object	Volume of Object	Buoyant force of water	Weight of Obj. in Water.
124.8 lb.	1.5ft^3		
196000 dynes.	100. cm^3		
39,200 nt.	2 m^3		
500.0 lb.	2 ft^3		
28400 dynes.	15 cm^3		
58800 nt.	2.5 m^3		

Problems - Do all work on a separate sheet of paper in a neat and orderly manner.

2. A 30 cm^3 block has a density of 1000 dynes/cm^3. If it is placed in alcohol which has a density of 700 dynes/cm^3 how much will it weigh in alcohol?

3. A 3.0 ft^3 object floats with 0.5 ft^3 above the water. How much does the object weigh?

4. A 10.0 ft^3 object weighs 499.2 lb. Will it sink or float? If it floats how much of the object will be under water, if it sinks what will it weigh in water?

5. Alcohol is only 0.7 as dense as water. An object weighing 100 lb. floats in water. If the volume of the object is 2.0 ft^3 will it sink or float in alcohol? Explain your answer.

4.232 The specific gravity of aluminum is 2.7. What is its density in dynes/cm^3?

$$2.7 = \frac{D_o}{980 \text{ dynes/cm}^3}$$

$$D_o = 2.7 \times 980 \text{ dynes/cm}^3$$
$$D_o = 2646 \text{ dynes/cm}^3$$

Note: To find density, knowing specific gravity multiply the specific gravity times the density of the standard in the system of units desired.

5. Measuring specific gravity.

5.1 Develop constant volume and constant weight expressions for specific gravity.

5.11 $\text{Sp. Gr.} = \frac{D_o}{D_s}$ and $D_o = \frac{W_o}{V_o}$, $D_s = \frac{W_s}{V_s}$

where: W_o = weight of object,
V_o = volume of object,
W_s = weight of standard
V_s = volume of standard

5.12 Substituting for D_o and D_s

$$\text{Sp. Gr.} = \frac{\frac{W_o}{V_o}}{\frac{W_s}{V_s}}$$

$$\text{Sp. Gr.} = \frac{W_o}{V_o} \times \frac{V_s}{W_s}$$

5.13 If $V_o = V_s$ then $\text{Sp. Gr.} = \frac{W_o}{W_s}$ or specific gravity equals the weight of the object divided by the weight of and equal volume of water.

5.14 If $W_o = W_s$ then $\text{Sp. Gr.} = \frac{V_s}{V_o}$ or specific gravity equals the volume of the standard divided by the volume of an equal weight of the objects.

5.2 For solids

5.21 Can use expression in 5.13.

5.22 W_s will equal the buoyant force exerted by water on the object.

Name______________________________ Date______________

Physics Worksheet on Specific Gravity.

Densities of water 62.4 lb./ft.^{3} 1.95 slugs/ft.^{3} 1 g/cm^3
980 dynes/cm^3 9,800 nt/m^3 1000 kg/m^3

1. Find the specific gravities of the following materials.

material	density	specific gravity
a. Salt water	1078 dynes/cm^3	....
b. Aluminum	168.5 lb./ft.^{3}	....
c. Glass	2500 kg/m^3	....
d. Lead	10.6 g/cm^3	....
e. Steel	73,500 nt/m^3	....
f. Gold	1204 lb./ft.^{3}	....
g. Copper	8.93 g/cm^3	....
h. Mercury	13,600 kg/m^3	....

2. Find the densities of the following in the requested units.

Specific gravity	Density	Specific gravity	Density
a. 2.5	......g/cm^3	f. 21.4	......lb./ft.^{3}
b. 11.3	......lb./ft.^{3}	g. 3.8	......g/cm^3
c. 7.8	......nt/m^3	h. 0.17	......slugs/ft.^{3}
d. 4.2	......dynes/cm^3	i. 1.3	......dynes/cm^3
e. 0.95	......kg/m^3	j. 5.7	......kg/m^3

3. Determine the specific gravity of each of the following.

Weight in air	Weight in water	specific gravity
a. 15 lb.	8 lb.	....
b. 750 dynes	225 dynes	....
c. 23 oz.	15 oz.	....
d. 9.80 nt.	6.45 nt.	....
e. 128 lb.	44 lb.	....

4. A rod sinks 2.10 inches in water. Find the specific gravity of the following liquids from the depth the rod sinks in the liquid.

	Depth rod sinks	Specific gravity
a.	6.0 in.	......
b.	3.0 in.	......
c.	1.4 in.	......
d.	0.6 in.	......
e.	0.13 in.	......

5. A sinker weighs 24.0 oz. in air and 16.0 oz. in water. Find the specific gravity of the following liquids.

	Buoyant Force in water	Weight in liquid	Buoyant Force of liquid	Specific gravity
a.	......	22.0 oz.	......	......
b.	......	12.0 oz.	......	......
c.	......	15.0 oz.	......	......
d.	......	20.0 oz.	......	......
e.	......	18.0 oz.	......	......

5.23 If object floats a sinker must be used to cause the object to sink in order to obtain the buoyant force.

5.3 For liquids.
  5.31 Using expression in 5.13
    5.311 Bottle or pycnometer method.
    5.312 Bulb or sinker method.

  5.32 Using expression in 5.14
    5.321 Called hydrometer method.
    5.322 Most widely used practical method for liquids.
      5.3221 Checking battery acid.
      5.3222 Checking antifreeze.
      5.3223 Measuring sugar concentration--Brix scale.
      5.3224 Measuring richness of milk--Lactometer.

6. Assignment - Worksheet on specific gravity.

LESSON 13 - Introduction to gases

1. Review worksheet on Specific Gravity.

2. Demonstrate some characteristics of gases.
  2.1 Gas fills its container - a small amount of bromine gas released into an evacuated flask will spread rapidly throughout the flask.
  2.2 Rapid diffusion of gas- open the gas cock for a moment and shortly the odor can be detected throughout the room.
  2.3 Gas exerts pressure - partially inflate a balloon and place under a bell jar on a vacuum pump plate. As the jar is evacuated the balloon expands.
  2.4 Gas has weight - weigh the weight of air globe, then exhaust it and weigh again. It will have slightly less weight.
  2.5 Gas exerts a buoyant force.
    2.51 Fill a balloon with illuminating gas and it will float in air.
    2.52 Buoyancy of air apparatus - a large hollow ball and a small solid cylinder are in balance on a small equal arm balance. When they are placed in a bell jar and the air removed from the bell jar the ball becomes heavier than the cylinder.

3. From the preceding demonstrations evolve the general concept of a gas.
    3.1 A form of matter with no definite size or shape.
    3.2 Composed of small particles which are constantly moving at a very rapid rate.

4. Pressure exerted by a gas.
    4.1 Caused by the collision of the rapidly moving particles with the sides of the container.
    4.2 Heating a gas causes the particles to move faster.
        4.21 Collide more frequently with the sides of the container.
        4.22 The greater number of collisions result in a higher pressure.

    4.3 Adding more gas raises pressure.
        4.31 Example--blowing up a balloon.
        4.32 More molecules present to collide with walls.
        4.33 More collisions with the walls so the pressure is greater.

    4.4 Volume effect.
        4.41 If the space occupied by the gas is reduced the molecules will not have to move as far to collide with the walls.
        4.42 A higher rate of collision results so the pressure will rise.
        4.43 The reverse will occur when the space is increased.

5. Assignment - Study for test on liquids.

LESSON 14 - Gases--Boyle's Law. Measuring standards for gases, buoyancy and atmospheric pressure.

1. Boyle's Law
    1.1 Run a simple pressure-volume experiment recording the pressures and volumes.
    1.2 Compute each pressure-volume product.
    1.3 Graph volume as a function of pressure.
    1.4 From the results evolve Boyle's Law - the volume of a dry gas is inversely proportional to the pressure exerted upon it providing the temperature remains constant.
        1.41 Formula: $P_1 V_1 = P_2 V_2$

where P_1 = original pressure, V_1=original volume,
P_2 = new pressure, V_2=new volume.

1.42 Examples

1.421 What pressure will be needed to reduce 100 ft.^{3} of air at a pressure of 15 lb./in.^{2} to a volume of 25 ft.^{3}?

$$15 \text{ lb./in.}^2 \times 100 \text{ ft.}^3 = P \times 25\text{ft.}^3$$

$$P_2 = \frac{15 \text{ lb./in.}^2 \times 100 \text{ ft.}^3}{25 \text{ ft.}^3}$$

$$P_2 = 60 \text{ lb./in}^2$$

1.422 What will be the volume of 6 liters of air at a pressure of 900 dynes/cm^2 when the pressure is lowered to 600 dynes/cm^2?

$$900 \text{ dynes/cm}^2 \times 6 \text{ liters} = 600 \text{ dynes/cm}^2 \times V_2$$

$$V_2 = \frac{900 \text{ dynes/cm}^2 \times 6 \text{ liters}}{600 \text{ dynes/cm}^2}$$

$$V_2 = 9 \text{ liters}$$

2. Measuring standards for gases.

2.1 Volume of a gas is dependent upon both pressure exerted on it and the temperature of the gas.

2.2 Equal volumes of the same gas at different temperatures or pressures will have different weights.

2.3 A standard temperature and pressure are needed for making gas measurements.

2.31 Called S.T.P. (Standard Temperature and Pressure)

2.32 Standard Temperature - 0° Centigrade

2.33 Standard Pressure - 760 mm of mercury.

3. Buoyancy of gases.

3.1 Review demonstration of the ball and cylinder of equal weight.

3.2 Like liquids, gases exert a buoyant force.

3.21 Force is much smaller due to the smaller density of gases.

3.22 Buoyant force of air at sea level is 1.3 oz./ft.^{3}

3.3 Lifting force of a gas.

3.31 Hydrogen has a density of 0.1 oz./ft.^{3}

3.32 On every cubic foot of hydrogen air exerts a buoyant force of 1.3 oz.

3.33 There is thus a net upward force of 1.2 oz./ft.^{3} exerted on the gas.

3.331 This difference is called the lifting force of the gas.

3.332 Can be used to determine the amount of gas needed to lift a balloon.

4. Atmospheric pressure

4.1 Illustrate atmospheric pressure with an open bell jar with a piece of rubber sheet over the opening. As the air is removed from the bell jar the atmosphere pushes the rubber sheet downward until it breaks.

4.2 The average pressure exerted by the atmosphere is 15 lb./in.^{2}
4.3 Measuring atmospheric pressure.
4.31 Discuss structure and operation of mercurial barometer.
4.32 Discuss structure and operation of aneroid barometer.

4.4 Applications of atmospheric pressure.
4.41 Drinking soda with a straw.
4.42 Lift pumps.
4.43 Siphons

5. Assignment - Worksheet on Boyle's Law and atmospheric pressure.

LESSON 15 - Change of State.

1. Review work sheet on Boyle's Law and atmospheric pressure.

2. Change of state - the change in form from solid to liquid, liquid to gas, solid to gas or the reverse of any of these.

3. Solid to liquid.
3.1 Called melting or fusion.
3.2 Melting point - the temperature at which melting occurs.
3.21 For crystalline solids there is a definite temperature.
3.22 For amorphous solids there is no definite temperature - the object starts to soften before it flows freely.
Examples: butter, glass tar.

4. Liquid to solid.
4.1 Called freezing or solidification.
4.2 Freezing point - the temperature at which freezing occurs.
4.21 For most crystalline materials it is the same as the melting point.
4.22 For amorphous materials again there is no specific temperature.

5. Liquid to gas.
5.1 Called vaporization or evaporation.
5.2 Volatile liquids.
5.21 Liquids which evaporate easily.
5.22 Alcohol, gasoline, paint solvents.
5.23 In the vapor state these materials can be highly flammable and consequently should be kept in closed container.

Name________________________________ Date____________________

Worksheet on Boyle's Law

Do all the problems in the space provided in a neat and orderly manner.

Boyle's Law $P_1V_1 = P_2V_2$

Let atmospheric pressure = 15 lb./in.^{2}, 30 in. of mercury or 76 cm of mercury.

1. A tire has a volume of 2 cubic feet. How many cubic feet of air at atmospheric pressure will be needed to fill the tire to a pressure of 30 lb./in.^{2}?

$V_2 =$ ....

2. A cylinder of gas has a volume of 4 ft.^{3} and the gas is under a pressure of 5 atmospheres. How much space will the gas take up at atmospheric pressure?

$V_2 =$ ....

3. How much pressure will be needed to reduce 500 ft.^{3} of air at normal pressure to a volume of 10 ft.^{3}?

$P_2 =$ ....

4. A balloon has a volume of 10 ft.^{3} on a day when the barometer reads 29 in. What is the volume of the balloon when the pressure is 31 in.?

$V_2 =$ ....

5. The following are readings taken from some gauges, what is the actual pressure?

a. 10 lb./in.^{2} .... d. 15 in of mercury ....

b. 10 cm of mercury .... e. 50 lb./in.^{2} ....

c. 3 atmospheres .... f. -12 lb./in.^{2} ....

6. The following are actual pressures what would be the gauge pressur

a. 45 lb./in.^{2} .... d. 20 lb./in.^{2} ....

b. 5 atmospheres .... e. 93 cm of mercury ....

c. 65 in. of mercury .... f. 10 lb./in.^{2} ....

- 5.3 Boiling point.
  - 5.31 Temperature at which rapid evaporation occurs with the liquid being violently disturbed.
  - 5.32 Temperature is dependent upon the pressure exerted on the liquid.
    - 5.321 Higher pressure--higher boiling point. Examples: pressure cookers, pressurized cooling systems in automobiles.
    - 5.322 Lower pressures--lower boiling points. Examples: concentrating fruit juices.

6. Gas to liquid.
   - 6.1 Called condensation.
   - 6.2 Can be caused by lowering the temperature of the gas below its boiling point.
   - 6.3 May also be accomplished by increasing the pressure upon the gas.
     - 6.31 Critical temperature--the highest temperature at which a gas may be liquified by increasing pressure.
     - 6.32 Applications
       - 6.321 Natural gas for rural home use.
       - 6.322 Liquid carbon dioxide fire extinquishes.

7. Distillation
   - 7.1 Process where a liquid is evaporated and then condensed.
   - 7.2 Used to separate and purify liquids.
     - 7.21 Demonstrate water distillation with a solution of colored water.
     - 7.22 Used in industry to produce alcohol, gasoline, turpentine, etc.

8. Sublimation
   - 8.1 The changing of a solid directly to a gas without going through the liquid state.
   - 8.2 Examples
     - 8.21 Dry ice
     - 8.22 Iodine crystals
     - 8.23 Moth balls.

9. Assignment - Study for test on gases and change of state.

LESSON 1 - Introduction to Measurement

1. What is measurement?
    - 1.1 Ask group what they do when they measure something.
    - 1.2 Evolve definition - The determination of the size or extent of something by comparison with a standard.

2. Why measure?
    - 2.1 Needed to describe an object.
    - 2.2 Necessary for standardization of parts for production of machines.
    - 2.3 Needed as a basis for buying and selling goods.

3. What is measured?
    - 3.1 Fundamental concepts
        - 3.11 Ones which must be defined.
        - 3.12 Length, weight or mass, and time.

    - 3.2 Derived units.
        - 3.21 Ones which are developed from combining the fundamental concepts.
        - 3.22 Area, volume, speed, and density.

4. Need for standards of measurement.
    - 4.1 Problem of buying and selling goods.
    - 4.2 Manufacturing component parts in different parts of the world and having them fit together properly.

5. Systems of measurement.
    - 5.1 English system.
        - 5.11 A system of independently developed units of measure.
        - 5.12 Multiples of units are not uniformly related
        Examples:

length	liquid volume
12 inches = 1 foot	16 ounces = 1 pint
3 feet = 1 yard	2 pints = 1 quart
1760 yards = 1 mile	4 quarts = 1 gallon

note: length multiples are 12 - 3 - 1760 which are not uniform or related and are not even the same as liquid volume.

- 5.2 Metric system
    - 5.21 A complete system of measure which was logically set up.
    - 5.22 Has a uniform series of multiples based upon powers of 10.
    - 5.23 A series of prefixes were established to identify these multiples.

5.24 Example

Prefix	Multiples		Symbol
	Decimal fraction	Power of 10	
tera	1,000,000,000,000.	10^{12}	T
giga	1,000,000,000.	10^{9}	G
mega	1,000,000.	10^{6}	M
kilo	1,000.	10^{3}	k
hecto	100.	10^{2}	h
deka	10.	10^{1}	da
deci	0.1	10^{-1}	d
centi	0.01	10^{-2}	c
milli	0.001	10^{-3}	m
micro	0.000001	10^{-6}	μ
nano	0.000000001	10^{-9}	n
pico	0.000000000001	10^{-12}	p

5.25 Metric system is the official system of measure in most countries of the world.

6. Measuring length.
   6.1 Metric System.
      6.11 Basic unit - the meter.
      6.12 Originally defined as 1/10,000,000 of the distance from the equator to the North Pole.
      6.13 Present standard is a multiple of the wavelength of a particular wavelength of light in the spectrum of Krypton.

   6.2 English system
      6.21 Basic unit - the foot.
      6.22 Multiples: inch, yard, mile.

   6.3 Interrelationships
      6.31 1 in. = 2.54 cm.
      6.32 1 m. = 39.37 in.

7. Assignment - Worksheet on metric prefixes and length units.

LESSON 2 - Measurement--Significant Figures

1. Review worksheet on metric prefixes and length units.

2. Significant digits
   2.1 Limits of a measuring instrument.
      2.11 Ask group if they can measure the thickness of a piece of paper with an ordinary ruler.
      2.12 Develop concept that the smallness of measurement is limited to the subdivision on the measuring instrument and that the smallest division recorded is only an approximation.

Name______________________________ Date______________

I.P. Physics - Worksheet on Metric prefixes and units of length.

1. Express the following measurements in millimeters.

a. 25.2 cm = ...mm. d. 0.271 cm = ...mm.

b. 1.734 m = ...mm. e. 1.853 km = ...mm.

c. 1.842 m= ....mm. f. 35.1 dm = ...mm.

2. Express the following measurements in the units requested.

a. 21.33 m. = ...cm. d. 183 cm. = ...m.

b. 1.237 km = ...m. e. 714.5mm. = ...m.

c. 73.5 mm.= ....cm. f. 2.184 m. = ...mm.

3. Express the following metric measurements in the requested English units.

a. 5.08 cm. = ...in. d. 6.0 m. = ...in.

b. 100. m. = ...yards e. 1.0 m. = ...ft.

c. 24.1 mm. = ...in. f. 65 cm. = ...in.

4. Express the following English measurements in the requested metric units.

a. 1 ft. = ...cm. d. 6 ft. = ...m.

b. 20. in.= ....cm. e. 3 yd. = ...m.

c. 100. yd.= ....m. f. 18 in. = ...cm.

2.2 Significant digits are those digits in a measurement which we are reasonably sure are correct.

2.3 Determining which digits are significant in a measurement.

2.31 All nonzero digits are significant.

2.32 Zero digits are significant when they are:

2.321 Between nonzero digits (108 cm, 1.05 m)

2.322 To the left of an expressed decimal point (10. in., 250,000. miles)

2.323 To the right of the decimal point and to the right of a nonzero digit (1.50 ft. 23.0 in.)

2.33 Zero digits are not significant when they are:

2.331 To the left of an implied decimal point and to the right of a nonzero digit (20 ft. 3,000 mi.)

2.332 To the right of a decimal point but to the left of a nonzero digit. (0.015 in., 0.0003 cm.)

3. Accuracy of a measurement.

3.1 Ask the class which is a more accurate measurement: 3 in. or 275 ft.

3.2 275 ft. is the more accurate measurement.

3.3 Accuracy is an indication of the number of significant digits in a measurement.

3.31 2.03 in. is 3 digit accuracy.

3.32 127.32 ft. is 5 digit accuracy.

4. Precision of a measurement.

4.1 Ask the class which is a more precise measurement. 0.002 in. or 21.4 in.

4.2 0.002 in. is the more precise measurement.

4.3 Precision is an indication of the smallness of the smallest unit measured.

5. Computation with measurements.

5.1 Special rules are needed to assure that the results do not indicate a greater accuracy or precision than the original measurements.

5.2 Addition and subtraction.

5.21 Round off all measurement to the precision of the least precise measurement before adding or subtracting.

5.22 Examples

5.221 add: 21.8 in., 3.47 in. and 128 in.
least precise measurement is 128 in.
so: 21.8 in. rounds to 22 in.
3.47 in. rounds to 3 in.
128 in. remains 128 in.
answer 153 in.

5.222 Subtract: 3.614 in. from 14.8 in.
14.8 in. is the least precise.
so: 14.8 in. remains 14.8 in.
3.614 in. rounds to 3.6 in.
answer 11.2 in.

5.3 Multiplication and division.
  5.31 Round off the answer to the accuracy of the least accurate measurement used in the multiplying or dividing.
  5.32 Examples
    5.321 Multiply 3.40 in. times 10. in. times 21.3in.
    product is 724.2 in.^{3}
    least accurate measurement is 10. in.
    so: the answer is 720 in.^{3}

    5.322 Divide 5376.71 in.^{2} by 24.1 in.
    quotient is 223.1
    least accurate measurement is 24.1 in.
    so: the answer is 223 in.

5.4 Note: in addition and subtraction the rounding occurs before the arithmetical operation, while in multiplication and division the rounding occurs after the operations.

6. Assignment - Worksheet on significant figures.

LESSON 3 - Measurement--Units of Measure

1. Review worksheet on significant figures.

2. Length measurements - review concepts developed in the first lesson.

3. Units derived from length measure.
  3.1 Area
    3.11 A measure of the extent of a surface.
    3.12 Basic unit is a square whose sides are a unit length in dimension.
      3.121 Metric system
        3.1211 Basic unit is the square meter (m^2)
        3.1212 Other units: square centimeter (cm^2)
        square millimeter (mm^2)

      3.122 English system
        3.1221 Basic unit is the square foot (ft.^{2})
        3.1222 Other units: square inch (in.^{2})
        square yard (yd.^{2})

Name_______________________________________ Date_______________

Worksheet on significant figures.

1. Determine the number of significant figures in these measurements.

123 in. ...... 501 ft. ...... 0.01040 in. ......

0.015 cm ...... 60. mi. ...... 2.0450 cm ......

6,400 m ...... 5.00 mm ...... 186,000 mi./sec. ......

2. Add the following measurements, expressing the answers in the requested units.

2.54 cm + 1.7432 m + 10.1 mm = ...cm

14.2 cm + 3.6 mm + 7.21 m = ...m

237 mm + 27.8 cm + 7.854 = ...mm

3. Subtract the following measurements, expressing the answers in the requested units.

2.53 cm - 0.87 mm = ...cm

9.873 m - 14.82 cm = ...m

3,422 cm - 4.8 m = ...m

4. Multiply the following measurements expressing the answers in the requested units.

2.42 cm x 6.3 mm = ...cm^2

48.6 cm x 2.32 m = ...m^2

61.8 mm x 18.1 cm x 2.4 cm = ...mm^3

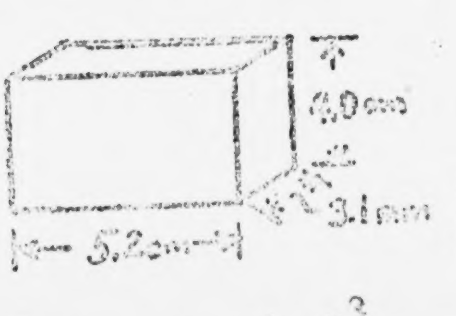
5. Divide the following measurements, expressing the answers in the requested units.

18.7 cm^2 divided by 3.6 cm = ...cm

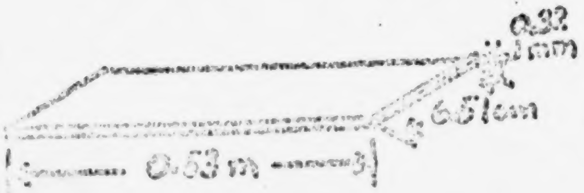
625.6 m^3 divided by 21.8 cm = ...m^2

1.65 cm^2 divided by 32.4mm = ...cm

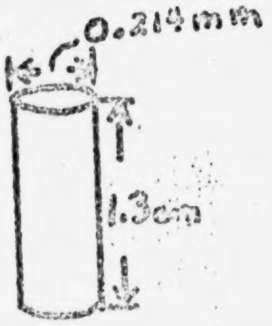
6. Calculate the volumes of the following objects, expressing the answers in the requested units.



V = ...cm^3



V = ...cm^3



V = ...mm^3

3.2 Volume
  3.21 A measure of the space occupied by an object.
  3.22 Basic unit is a cube whose sides are a unit length in dimension.
    3.221 Metric system
      3.2211 Basic unit is the cubic meter(m^3)
      3.2212 Other units: cubic centimeter(cm^3) cubic millimeter (mm^3)
      3.2213 The liter is a convenient practical volume unit which is between a cubic centimeter and a cubic meter.
        1000 cm^3 = 1 liter
        1000 liters = 1 m^3

    3.222 English system
      3.2221 Basic unit is the cubic foot($ft.^3$)
      3.2222 Other units: cubic inch ($in.^3$) cubic yard ($yd.^3$)
      3.2223 The quart is a convenient practical volume unit which is nearly the same as the liter (1 liter=1.06 qt.)

4. Mass measurements
  4.1 Mass is commonly considered the amount of matter contained in an object but would be better to consider it the measure of an object's inertia.
  4.2 Metric system
    4.21 Basic unit is the kilogram (kg) which has been established as the amount of mass contained in one liter of water at the temperature where water is most dense (about 4°C) and weighs about 2.2 lb.
    4.22 Other convenient units: gram(g) and milligram (mg)

  4.3 English system
    4.31 Generally mass is considered as a derived unit based upon other fundamental concepts.
    4.32 Basic unit is the slug.
    4.33 The slug has a weight of about 32 pounds.

5. Force or weight measurements
  5.1 Generally force is that which produces or prevents motion or has the tendency to do so.
  5.2 Metric units.
    5.21 Like English mass measurements these are derived units.
    5.22 Basic metric unit is the newton (nt.)
    5.23 Another unit is the dyne.
    5.24 A kilogram weighs about 9.8 nt. and a gram weighs about 980 dynes.

  5.3 English units
    5.31 The force unit is defined from the weight at a particular location of a particular fraction of the basic metric kilogram.
    5.32 The basic unit is the pound.
    5.33 Another convenient unit is the ounce.

6. Time
    6.1 This is the only unit which is the same for all systems of measure.
    6.2 The basic unit is the second (sec.)
    6.3 Other units are the minute and hour.

7. Chart of measurement units.
    7.1 Pass out blank unit charts.
    7.2 These are to become an integral part of the notebook.
    7.3 Illustrate how they are to be filled in. (see completed chart)
    7.4 As new units are developed they are to be added to the chart.

8. Assignment - Complete unit chart and worksheet on units of measure.

Name________________________________ Date________________

Worksheet on Units of Measure.

1. Complete the following metric to English conversions.

   a. 100 m = ...ft.
   b. 4.0 liters = ...qt.
   c. 5.4 kg. weigh = ...lb.
   d. 25.4 cm = ...in.
   e. 16.2 liters = ...qts.
   f. 98 nt. = ...lb.
   g. 1960 dynes = ...lb.
   h. 1.5 km = ...mi.

2. Complete the following English to metric conversions.

   a. 15 lb. is the weight of.........kg.
   b. 23 in. = ...cm.
   c. 4 qt. = ... liters
   d. 32 oz. = ...nt.
   e. 100 yd. =.........m.
   f. 3 lb. = ...dynes
   g. 2 gal. = ...liter
   h. 1 slug = ...kg.

3. Complete the following conversions.

a a. 225 g. weigh ....dynes
   b. 4 slugs weigh ....lb.
   c. 18 kg. weigh ....nt.
   d. 2,500 cm. = ...liters
   e. 54 oz. = ...lb.
   f. 0.75 liters = ...cm^3
   g. 96 lb. is the weight of ....slugs.
   h. 186 nt. is the weight of ....kg.

Name________________________________ Date submitted_____________

Experiment #1 - MEASUREMENT OF LENGTH WITH A METER STICK

Purpose of experiment

1. To develop the relationships between English and Metric units of length.
2. To develop technique in measuring lengths with a meter stick and performing calculations with these measurements.

Apparatus

Meter stick, English inch divided into tenths, wood block, metal block (1" maximum dimension), metal cylinder (1" maximum dimension).

Procedure

Part 1 Relationship between English and Metric Units of length.

The length of the table is measured with the English side of the meter stick starting with the left end of the table. The top edges of the table are rounded off, therefor to locate the edge of the table place the wood block against the edge of the table and using the edge of the block as the reference point start the measuring. Since the meter stick is not longer than the table, it will have to be moved and the wood block will be used to mark the end of the meter on the table. The length is recorded to the nearest tenth of an inch, since the inch on the meter stick is divided into common fractions use the paper scale which is divided into tenths for the final measurement. The measurement will then be repeated starting from the opposite end of the table. If the two measurement are different, a third trial will be made and the average length calculated.

In a similar manner the length of the table will be measured to the nearest tenth of a centimeter.

From this data the length of an inch in centimeters and the length of a meter in inches will now be determined and compared with the accepted values.

Part 2 Measuring the volume of solids.

The length, width, and thickness of the metal block will be measured to the nearest tenth of a centimeter. At least two trials of each measurement will be made and from the average values of each dimension the volume of the block will be calculted.

In a similar fashion the volume of the cylinder will be calculated.

Data

Part 1

Trial	Length of table (inches)	Length of table (centimeters)
1		
2		
3		
Average		

Experiment #1 - Page 2

1 inch equals____cm. Accepted value 1 in. equals 2.54 cm. error___cm

1 meter equals____in. Accepted value 1 m equals 39.4 in. error___in.

Part 2

Trial	Block#				Cylinder#		
	Length (cm)	Width (cm)	Thickness (cm)	Volume (cm^3)	Length (cm)	Diameter (cm)	Volume (cm^3)
1				☒			☒
2				☒			☒
3				☒			☒
Average							

Questions

1. Why start at the opposite end of the table when making a second measurement?

____

____

2. What is the basic unit of length in the English System?______

What is the basic unit of length in the Metric System?_______

3. How do the basic units of length in the Metric and English Systems compare?_______________________________

4. What may be some of the reasons that your values for the length of the inch in centimeters and length of the meter in inches were different from the accepted values?

____

____

____

____

____

Name______________________ Table________ Date________

Partner___________________ Instructor's Approval______________

EXPERIMENT #1 - MEASUREMENT OF LENGTH WITH A METER STICK - ORIGINAL DATA SHEET

Part 1

Trial	Length of table (inches)	Length of table (centimeters)
1		
2		
3		
Average		

1 inch equals.....cm. Accepted value 1 in. equals 2.54 cm error ......cm

1 meter equals...... in. Accepted value 1 m equals 39.4 in. error.....in

Part 2

Trial	Block#				Cylinder #		
	Length (cm)	Width (cm)	Thickness (cm)	Volume (cm^3)	Length (cm)	Diameter (cm)	Volume (cm^3)
1				X			X
2				X			X
3				X			X
Average							

Name_________________________________ Date submitted____________

Experiment #2 - MEASUREMENTS WITH THE VERNIER CALIPER

Purpose of experiment

1. To develop understanding and experience in measuring with a vernier caliper.
2. To compare the accuracy of measurements made with the vernier caliper and the meter stick.

Apparatus

Vernier caliper, metal block and cylinder used in Experiment #1, wood block with cylindrical hole in one end.

Procedure

Part 1 The dimensions of the metal block and cylinder will be measured to the nearest hundredth of a centimeter. At least two trials will be made for each dimension. The volume of each object will be calculated from the average values of its dimensions.

Part 2 The overall volume of the wood block will be determined in inches in the same manner as part 1. The volume of the hole will be calculated by finding the diameter and depth of the hole in inches with the appropriate parts of the vernier caliper.

The volume of the wood in the block can then be found by subtracting the volume of the hole from the overall volume of the block.

Data

Part 1

Trial	Block #				Cylinder #		
	Length (cm)	Width (cm)	Thickness (cm)	Volume (cm^3)	Length (cm)	Diameter (cm)	Volume (cm^3)
1				X			X
2				X			X
3				X			X
Average							
Average from Exp. #1							

Experiment #2 - Page 2

Part 2

Block # ______

Trial	Block				Hole		
	Length (in)	Width (in)	Thickness (in)	Volume (in^3)	Length (in)	Diameter (in)	Volume (in^3)
1				X			X
2				X			X
3				X			X
Average							

Volume of wood in the block ________ in^3

Questions

1. How does the accuracy of the vernier caliper measurements compare with the same measurements made with a meter stick?

____

____

2. What would be three uses that you could make of a vernier caliper in the shop course that you are taking?

a. ____

b. ____

c. ____

3. Examine the scales on the barometer in the laboratory. How do they compare with the scales on the vernier caliper?

____

____

____

Name________________________ Table__________ Date____________

Partner_____________________ Instructor's Approval______________

Experiment # 2 - Measurements with the Vernier Caliper - Original Data Sheet

Part 1

Trial	Block #				Cylinder #		
	Length (cm)	Width (cm)	Thickness (cm)	Volume (cm^3)	Length (cm)	Diameter (cm)	Volu (cm^3)
1				X			X
2				X			X
3				X			X
Average							
Average from Exp. #1							

Part 2

Block #_____

Trial	Block				Hole		
	Length (in)	Width (in)	Thickness (in)	Volume (in^3)	Length (in)	Diameter (in)	Volume (in^3)
1				X			X
2				X			X
3				X			X
Average							

Volume of wood in the block _______in^3

Name____________________________________Date submitted____________________

Experiment #3 - MEASUREMENTS WITH THE MICROMETER CALIPER

Purpose of experiment

1. To develop understanding and experience in measuring with a micrometer caliper.
2. To compare accuracy of measurements of the micrometer cliper, vernier caliper, and meter stick.

Apparatus

Micrometer caliper, English and Metric scales, the metal block and cylinder used in the two previous experiments, set of four samples of wire of different gauges.

Procedure

Part 1

The dimensions of the metal block and cylinder will be measured to the nearest thousandth of a centimeter. At least two trials of each will be made. The volume of each object will be calculated from the average values of each dimension.

Part 2

The diameter of each wire will be measure in mils. Several trials should be made at different places along the wire and the average value recorded and compared with the accepted value for each gauge number.

Data

Part 1

Trial	Block #				Cylinder #		
	Length (cm)	Width (cm)	Thickness (cm)	Volume (cm^3)	Length (cm)	Diameter (cm)	Volume (cm^3)
1				☒			☒
2				☒			☒
3				☒			☒
Average							
from Exp. #2							
Exp. #1							

Part 2

Gauge Number	Measured Diameter (mils)	Accepted Diameter (mils)	Difference (mils)

Questions

1. How does the accuracy of the micrometer measurements compare with the same measurements made with the vernier caliper and the meter stick?

____

____

____

2. What would be three uses that you could make of a micrometer caliper in the shop course that you are taking?

a. ______________________________

b. ______________________________

c. ______________________________

3. Why should you use the ratchet thimble when closing the spindle of the caliper? ______________________________

____

____

4. How do the diameters of the wires compare with their gauge numbers? ______________________________

____

____

Name________________________ Table__________ Date__________

Partner______________________ Instructor's Approval__________

EXPERIMENT #3 - MEASUREMENT WITH THE MICROMETER CALIPER - ORIGINAL DATA SHEET

Part 1 Block #_____ Cylinder #_____

Trial	Length (cm)	Width (cm)	Thickness (cm)	Volume (cm^3)	Length (cm)	Diameter (cm)	Volume (cm^3)
1							
2							
3							
Averages							
from Exp. #2							
Exp. #1							

Part 2

Gauge Number	Diameter Measured (mils)	Accepted Diameter (mils)	Difference (mils)

Name______________________ Date submitted______________

Experiment #4 - MASS DENSITY OF SOLIDS

Purpose of experiment

1. To develope understanding and experience in measuring with a trip balance.
2. To determine mass density of regular solids.
3. To determine the volume of irregular solids and compute their mass densities.

Apparatus

Triple beam balance, metal block, metal cylinder, vernier caliper, 100 ml graduated cylinder, four irregularly shaped metal solids.

Procedure

Part 1 - Density of regular solids.

The dimensions of the metal block and cylinder will be measured with the vernier caliper to the nearest hundredth of a centimeter. From this data the volume of each will be calculated. The mass will be measured on the trip balance to the nearest tenth of a gram and the mass density calculated from the information obtained.

Part 2 - Density of irregular solids.

The mass of each irregular solid will be measured on the trip balance before the volume is measured.

The volume of each irregular solid will be measured by placing enough water in the graduate to cover the solid. The volume of the water will be recorded and then the solid will be carefully placed in the cylinder. The new volume will then be recorded and the difference between this new volume and the original one will be the volume of the solid. This volume will be used along with the mass of the solid to calculate the mass density of each solid.

Part 3

The mass densities calculated in parts 1 & 2 will then be compared with the accepted mass densities.

Data

Part 1

Object	Material	Length (cm)	Width (cm)	Thickness (cm)	Diameter (cm)	Volume (cm^3)
Block						
Cylinder						

Experiment #4 - Page 2

Object	Material	Mass (g)	Volume (cm^3)	Density (g/cm^3)
Block				
Cylinder				

Part 2

Material	Volume of water (cm^3)	Volume of water & solid (cm^3)	Volume of solid (cm^3)	Mass of solid (g)	Mass Density of solid (g/cm^3)

Part 3

Object	Material	Calculated Density (g/cm^3)	Accepted Density (g/cm^3)	Error (g/cm^3)
Block				
Cylinder				
Irregular solids				

Questions

1. What is an advantage to finding volume by the water displacement method?

____

____

2. Which is more accurate, direct measurement or the displacement method?

____

____

3. What limitations are there to the displacement method of measuring volume?

____

____

4. Could another liquid, gasoline or oil, be used in the displacement method?______ Explain________________________

____

____

Name________________ Table____________ Date____________

Partner________________ Instructor's Approval____________

EXPERIMENT #4 - MASS DENSITY OF SOLIDS - ORIGINAL DATA SHEET

Part 1

Object	Material	Length (cm)	Width (cm)	Thickness (cm)	Diameter (cm)	Volume (cm^3)
Block						
Cylinder						

Object	Material	Mass (g)	Volume (cm^3)	Density (g/cm^3)
Block				
Cylinder				

Part 2

Material	Volume of water (cm^3)	Volume of water & solid (cm^3)	Volume of solid (cm^3)	Mass of solid (g)	Mass Density of solid (g/cm^3)

Part 3

Object	Material	Calculated Density (g/cm^3)	Accepted Density (g/cm^3)	Error (g/cm^3)
Block				
Cylinder				
Irregular solids				

Name________________________________Date submitted________________

Experiment #5 - MASS DENSITY OF LIQUIDS

Purpose of experiment

1. To develop understanding and experience in measuring volumes of liquids with a buret.
2. To measure the mass density of liquids.

Apparatus

Triple beam balance, 50 ml buret, buret rod, buret clamp, 2-100 ml beakers, four liquids of different densities.

Procedure

Since a liquid has no definite shape it presents a problem in measuring. The volume cannot be measured by putting it on the table and measuring its length, width, and thickness. Its mass cannot be readily measured by pouring it on the pan of the balance. The liquid must be held in a container. In this experiment a known volume will be placed in a beaker and the combined mass of the liquid and beaker measured. If the mass of the beaker is known, then the mass of the liquid can be obtained.

The volume of the liquid is found by filling the buret with the liquid and then allowing the liquid to be drawn off into the beaker. The level of the liquid in the buret is recorded before and after the sample is drawn out. The volume of the liquid taken from the buret is found from the difference in the two levels.

Four trials will be made using a different liquid for each trial. The density for each liquid will be calculated and compared with the accepted values.

Data

Trial	Liquid Used	Initial buret Reading (ml)	Final buret Reading (ml)	Volume of Liquid (ml)	Mass of beaker (g)	Mass of beaker &liquid (g)	Mass of liquid (g)
1							
2							
3							
4							

Experiment #5 - Page 2

Trial	Experimental Mass Density of Liquid (g/ml)	Accepted Mass Density of Liquid (g/ml)	Error (g/ml)
1			
2			
3			
4			

Questions

1. Why is the buret graduated with the zero at the top instead of the bottom?

2. Why must you be sure to have the tip of the buret filled with liquid before drawing off the measured volume?

3. What effect might temperature have on the density of the liquid?

4. What may be some reasons for error in your results?

Name________________________ Table__________ Date__________

Partner_____________________ Instructor's Approval______________

EXPERIMENT # 5 - MASS DENSITY OF LIQUIDS - ORIGINAL DATA SHEET

Trial	Liquid Used	Initial Buret Reading (ml)	Final Buret Reading (ml)	Volume of Liquid (ml)	Mass of Beaker (g)	Mass of Beaker & Liquid (g)	Mass of Liquid (g)
1							
2							
3							
4							

Trial	Experimental Mass Density of Liquid (g/ml)	Accepted Mass Density of Liquid (g/ml)	Error (g/ml)
1			
2			
3			
4			

Name______________________________ Date submitted_______________

Experiment #6 - BUOYANCY OF A LIQUID

Purpose of experiment

To study the factors effecting the buoyant force of a liquid upon a solid placed in the liquid.

Apparatus

Triple beam balance, buret rod, overflow can, catch bucket, 250 ml beaker, four solid objects, alcohol, string.

Procedure

Part 1 - Water used as the liquid.

A piece of string is fastened to each solid and by means of this string the object is hung under the balance which has been elevated on the buret rod. The mass of the object is measured to the nearest tenth of a gram. The mass of it in water is found by placing the beaker of water under the balance and submerging the solid in the water. Care should be taken to be sure that the object is completely submerged.

After the mass of the objects in air and in water has been measured then the weight of the water displaced is found. This is done by using the overflow can and catch bucket. First the mass of the catch bucket is measured. The overflow can is filled with water until the level is above the spout in the side of the can. The excess water is allowed to flow out of the spout. Care should be taken not to disturb the overflow can while this is happening, the water should be allowed to stop without any outside disturbance. The object will be placed carefully into the overflow can and the water which overflows will be caught in the catch bucket. The catch bucket and the liquid is then placed on the balance and the mass determined. From this data the mass of the water displaced by the object can be found.

The process will be repeated for all four objects.

Part 2 - Alcohol used as the liquid.

The procedure is the same as in part 1 except that alcohol is used in place of the water.

Data

Part 1

Trial	Mass of object in air (g)	Mass of object in water (g)	Buoyant force of water (g)	Mass of catch bucket &water (g)	Mass of catch bucket (g)	Mass of water displaced (g)	Experimental error (g)
1							
2							
3							
4							

Part 2

Trial	Mass of object in air (g)	Mass of object in alcohol (g)	Buoyant force of alcohol (g)	Mass of catch bucket (g)	Mass of catch bucket & alcohol (g)	Mass of alcohol displaced (g)	Experimental error (g)
1							
2							
3							
4							

Questions

1. How does the buoyant force of the water on the submerged block compare with the mass of the water displaced?

2. How does the buoyant force of alcohol on the submerged block compare with the mass of the alcohol displaced?

3. Alcohol is less dense than water. If the liquid used had been more dense than water, how would the buoyant force of this liquid compare with the buoyant force of water on the same object?

4. If the object is less dense than water what will happen when it is placed in water?

5. What reasons may account for the difference between the buoyant force that you measured and the mass of the liquid which was displaced?

Name________________________ Table________ Date________

Partner________________________ Instructor's Approval__________

Experiment #6 — BUOYANCY OF A LIQUID — ORIGINAL DATA SHEET

Part 1

Trial	Mass of object in air (g)	Mass of object in water (g)	Buoyant force of water (g)	Mass of catch bucket (g)	Mass of catch bucket & water (g)	Mass of water displaced (g)	Experimental error (g)
1							
2							
3							
4							

Part 2

Trial	Mass of object in air (g)	Mass of object in alcohol (g)	Buoyant force of alcohol (g)	Mass of catch bucket (g)	Mass of catch bucket & alcohol (g)	Mass of alcohol displaced (g)	Experimental error (g)
1							
2							
3							
4							

Name______________________________ Date submitted____________________

Experiment #7 - SPECIFIC GRAVITY OF SOLIDS

Purpose of experiment

1. To determine the specific gravity of solids denser than water.
2. To determine the specific gravity of solids less dense than water.

Apparatus

Triple beam balance, buret rod, battery jar, 3 solids more dense than water, 2 solids less dense than water, string.

Procedure

Part 1 - Solids more dense than water.

The mass of each object is measured first in air and then when submerged in water. From this information the buoyant force of water is determined. The specific gravity of each object can then be calculated by dividing the mass of the object in air by the buoyant force of the water.

Part 2 - Solids less dense than water.

The mass of the object in air is measured in the same way as in part 1. To determine the buoyant force, the object will need to be submerged. The lead object from part 1 will be used as the sinker. The sinker is tied to the object and the combined mass of the two objects when submerged is measured. The buoyant force on the object alone is calculated by subtracting the mass of both in water from the sum of the mass of the object in air and the sinker in water. The specific gravity is then calculated in the same manner as in part 1.

Data

Part 1 - Solids more dense than water.

Trial	Material	Mass in air (g)	Mass in water (g)	Buoyant force (g)	Specific Gravity
1					
2					
3					

Part 2 - Solids less dense than water.

Trial	Material	Mass in air (g)	Mass of sinker in water (g)	Mass of solid in air and sinker in water (g)	Mass of both in water (g)	Buoyant force (g)	Specific Gravity
1							
2							

Questions

1. What definition of specific gravity was used in this experiment?

____

____

____

2. Show two ways that specific gravity can be used in the shop course that you are taking.

a.____

____

b.____

____

3. What may be some sources of error in this experiment?

____

____

____

____

____

____

Name________________ Table__________ Date__________

Partner________________ Instructor's Approval__________

EXPERIMENT #7 - SPECIFIC GRAVITY OF SOLIDS - ORIGINAL DATA SHEET

Part 1 - Solids more dense than water.

Trial	Material	Mass in air (g)	Mass in water (g)	Buoyant force (g)	Specific Gravity
1					
2					
3					

Part 2 - Solids less dense than water.

Trial	Material	Mass in air (g)	Mass of sinker in water (g)	Mass of solid in air and sinker in water (g)	Mass of both in water (g)	Buoyant force (g)	Specific Gravity
1							
2							

Name______________________________ Date submitted________________

Experiment #8 - ELASTICITY AND ELASTIC MODULUS

Purpose of experiment

1. To study the effects of tension on a spring.
2. To calculate the elastic modulus for a spring.

Apparatus

Brass spring, weight hanger, slotted weights, meter stick, caliper jaw for meter stick, instrument rod and collar hook.

Procedure

The spring is hung from the collar hook on the instrument rod. The height of the lower end of the spring is measured with the meter stick to which has been attached the caliper jaw to aid in locating the position of the spring. Weights are added to the spring in 50 gram units and the total amount of stretch for each trial is recorded.

The elastic modulus for each trial is calculated by dividing the total stretch of the spring by the amount of weight placed on the spring. After the individual values are calculated the average modulus is determined.

A graph is then constructed using the values of stretch for the y-axis and the weights applied for the x-axis.

Data

Trial	Mass applied (g)	Weight applied (oz.)	Height above table (cm)	Stretch of spring (cm)	Elastic Modulus (cm/oz.)
1	0				
2	50				
3	100				
4	150				
5	200				
6	250				
7	300				
8	350				
9	400				
10	450				

Average value for elastic modulus________cm/oz.

Questions

1. How do the individual values for the elastic modulus compare?

2. What is the shape of the graph?

3. From your answers to questions #1 and #2, what can be said about the relationship between stretch and the force applied?

4. Where might it be desirable to use a material with a low elastic modulus?

Explain

5. Where might it be desirable to use a material with a high elastic modulus?

Explain

Name______________________________ Table____________________ Date______________

Partner____________________________ Instructor's Approval________________________

Experiment #8 - ELASTICITY AND ELASTIC MODULUS - ORIGINAL DATA SHEET

Trial	Mass applied (g)	Weight applied (oz.)	Height above table (cm)	Stretch of spring (cm)	Elastic Modulus (cm/oz.)
1	0				
2	50				
3	100				
4	150				
5	200				
6	250				
7	300				
8	350				
9	400				
10	450				

Average value for elastic modulus__________cm/oz.

2nd UNIT

LESSON 1 - Nature and Kinds of Forces

1. Nature of a force.

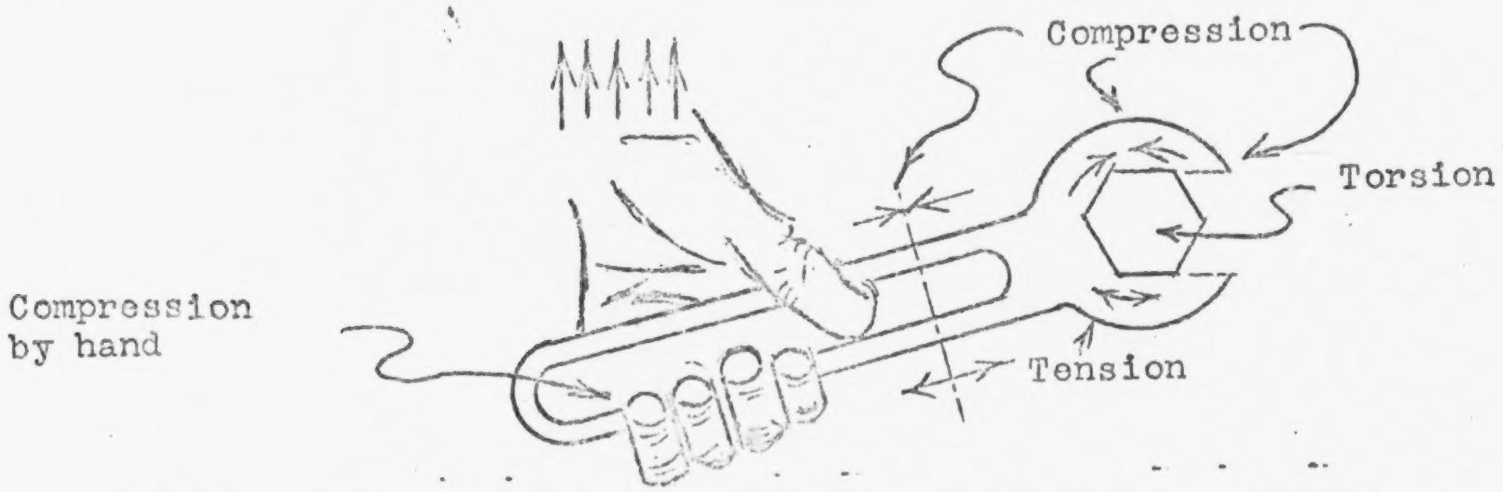
1.1 Ask the group what a force can do.
1.11 Cause an object to move.
1.12 Cause an object to stop moving.
1.13 Cause a moving object to change direction.
1.14 Hold an object in place.

1.2 Evolve definition of a force - that which produces or prevents motion or has the tendency to do so.
1.3 How is a force applied?
1.31 Ask the group how they would exert a force upon another person.
1.32 Evolve concept that to exert a force physical contact must occur.
1.33 There are three possible exceptions.
1.331 Those forces which set up force fields.
1.332 Gravitational, electrical and magnetic forces.

2. Kinds of force

2.1 Tension force - attempts to stretch the object.
2.2 Compression force - attempts to squeeze or shorten the object.
2.3 Torsional force - attempts to twist the object.
2.4 Shearing force - attempts to cause the material to slip or slide.
2.5 Applications of these kinds of force.
2.51 Hand saw cutting wood.
2.511 Hand exerts a compression force on the saw.
2.512 Teeth experience a tension force on the cutting face and a compression force on the opposite face.
2.513 Teeth exert a shearing force on the wood.

2.52 Wrench tightening a bolt.



3. Assignment - Draw a sketch of a hammer driving a nail and a pair of tin snips cutting metal and label the regions where the different types of forces are acting.

- Effort and Resistance Forces and Torques

mine and discuss sketches made for homework.

ort force.
Force which is applied to a machine.
Symbolically represented by F_E.

istance force.
Force which a machine is able to apply as a result of the effort force.
Symbolically represented by F_R.

que
Illustrate concept of torque with a meter stick and two masses, one of a kilogram, one of 500 grams.
4.11 Have a student hold the meter stick horizontally by one end.
4.12 Place the kilogram mass near the hand and start moving it out noting the increased difficulty in holding the meter stick.
4.13 Have the student note if there is any apparent difference in effect when the kilogram mass is replaced by the 500 gram mass but placed twice as far from the hand.

Definition of torque - The effectiveness of a force in producing rotation.
Factors effecting the magnitude of a torque.
4.31 Size of the force.
4.32 Distance the force is applied from the point of rotation (pivot).
4.33 Direction of the force in respect to the distance from the pivot.

Expressing the torque.
4.41 Magnitude of the torque equals the product of the force times the distance to the pivot (provided force is at right angles to the distance line)
4.42 Formula

$$L = F \times l$$

where L is the torque
F is the force applied
l is the distance to the pivot

4.43 Units for torque.
lb.-ft., lb.-in., cm-dyne, m-nt.
4.44 Examples
4.441 A force of 5 lb. is applied on the end of a wrench 6 in. long. How much torque will be applied to the nut which is being tightened?

$$L = 5 \text{ lb.} \times 6 \text{ in.}$$
$$L = 30 \text{ lb.-in.}$$

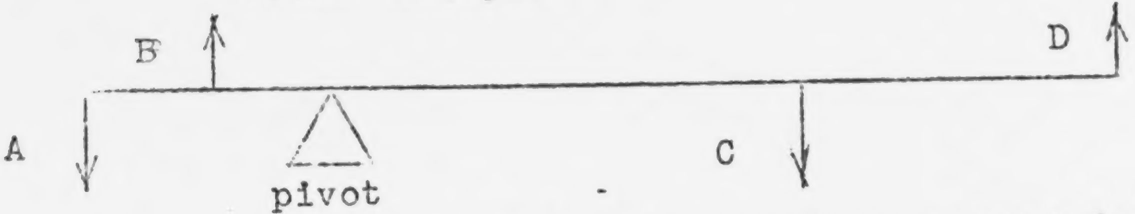
4.442 How far from the pivot will a force of 25 lb. have to be applied to produce a torque of 350 lb.-ft.?

$$350 \text{ lb.-ft.} = 25 \text{ lb.} \times l$$

$$l = \frac{350 \text{ lb.-ft.}}{25 \text{ lb.}}$$

$$l = 14 \text{ ft.}$$

4.45 Direction of a torque.
  4.451 Based upon the direction in which the object will rotate.
  4.452 Direction taken from the movement of the clock - i.e. clockwise or counterclockwise.
  4.453 Example



Forces A and D produce counterclockwise torque.
Forces B and C produce clockwise torques.

4.5 Equilibrium of torques.
  4.51 An object is said to be in equilibrium or balance when the clockwise torque equals the counterclockwise torque.
  4.52 Applications
    4.521 Two people of different weights balancing on a see-saw.
    4.522 The balances used in the laboratory.

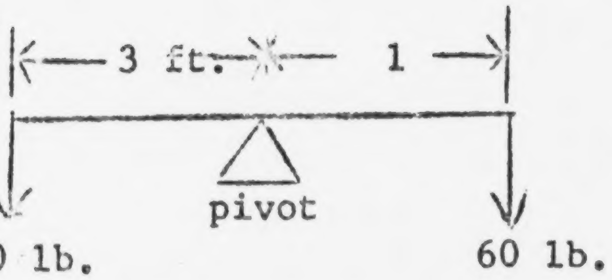
  4.53 Symbolic representation
    4.531 $F_c l_c = F_{cc} l_{cc}$

where F_c is the clockwise producing force

l_c is the distance of the clockwise force to the pivot
F_{cc} is the counterclockwise producing force
l_{cc} is the distance of the counterclockwise force to the pivot.

    4.532 Example:
A 50. lb. boy sits on one end of a six foot plank which is pivoted in the middle. How far from the middle on the other side must a 60 lb. boy sit in order to balance the plank?

diagram



$$50\text{ lb.} \times 3\text{ ft.} = 60\text{ lb.} \times 1$$

$$1 = \frac{50\text{ lb.} \times 3\text{ ft.}}{60\text{ lb.}}$$

$$1 = 2.5\text{ ft.}$$

5. Assignment - Worksheet on torques.

LESSON 3 - Mechanical Advantage and Work

1. Review worksheet on torque.

2. Mechanical advantage.
   2.1 What is the purpose of a machine?
      2.11 Increases force
      2.12 Increases speed or distance
      2.13 Changes direction

   2.2 The number of times a machine increases the force or speed is called mechanical advantage.
   2.3 Mechanical advantage of force.
      2.31 The number of times the machine increases the effort force.
      2.32 Measured by the ratio of the resistance force to the effort force.
         3.321 Formula:

$$MA_F = \frac{F_R}{F_E}$$

where: MA_F is the mechanical advantage of force.
F_R is the resistance force.
F_E is the effort force.

         3.322 Examples:
            3.3221 What is the mechanical advantage of force of a machine where a force of 25 lb. applied to the machine results in the machine exerting a force of 225 lb.?

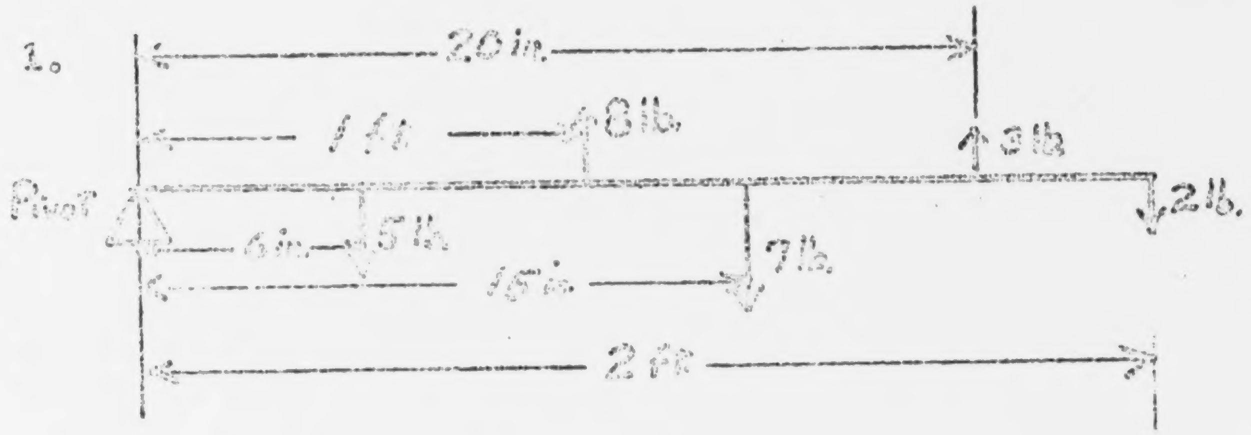
$$MA_F = \frac{225\text{ lb.}}{25\text{ lb.}}$$

$$MA_F = 9$$

Name____________________________________ Date_____

Worksheet on Torques.

1.


20 in.
1 ft
8 lb.
3 lb
Pivot
2 lb.
6 in.
5 lb.
7 lb.
15 in.
2 ft

What torque is produced by each of the above forces?

5 lb. force ....

7 lb. force ....

2 lb. force ....

8 lb. force ....

3 lb. force ....

2. How far from the pivot must the following forces be applied to produce a torque of 840 m-nt.?

a) 420 nt. ....

b) 210 nt. ....

c) 120 nt. ....

d) 140 nt. ....

e) 280 nt. ....

f) 168 nt. ....

3. How much force must be applied at the following distance to produce a torque of 1440 lb.-ft.

a) 2 ft. ....

b) 8 ft. ....

c) 10 ft. ....

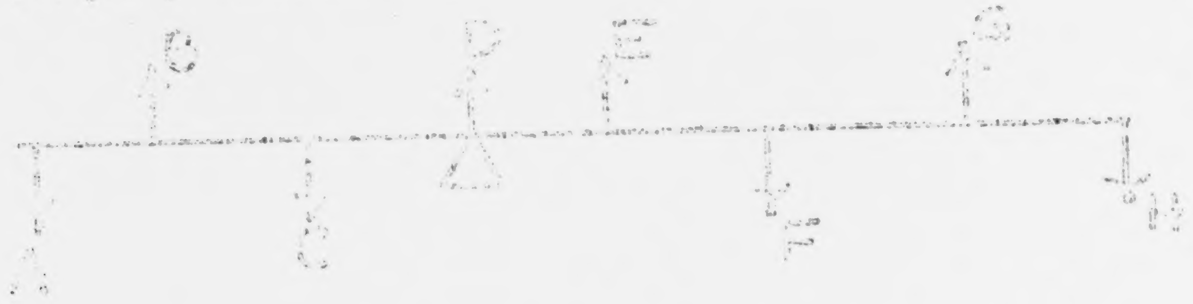
d) 3 ft. ....

e) 18 in. ....

f) 9 ft. ....

Name________________________________ Date______

4. In the following diagram determine the direction of the torque produced by each force.



Force	Torque Direction	Force	Torque Direction
A		E	
B		F	
C		G	
D		H	

2.3222 A machine has an MA_F of 6.5. How much effort force will have to be applied to lift a weight of 175.5 lb.?

$$6.5 = \frac{175.5 \text{ lb.}}{F_E}$$

$$F_E = \frac{175.5 \text{ lb.}}{6.5}$$

$$F_E = 27 \text{ lb.}$$

2.4 Mechanical advantage of speed.

  2.41 The number of times the machine increases the speed or distance.

  2.42 Measured by the ratio of the distance the resistance force moves to the distance the effort force moves.

    2.421 Formula: $MA_S = \frac{S_R}{S_E}$

where: MA_S is the mechanical advantage of speed.
S_R is the distance the resistance force moves.
S_E is the distance the effort force moves.

    2.422 Examples:

      2.4221 What is the MA_S of a machine where the effort force moves 6 inches while the resistance force moves 33 inches?

$$MA_S = \frac{33 \text{ in.}}{6 \text{ in.}}$$

$$MA_S = 5.5$$

      2.4222 A machine has an MA_S of 6.3. How far will the resistance move when the effort moves 8 in.?

$$6.3 = \frac{S_R}{8 \text{ in.}}$$

$$S_R = 8 \text{ in.} \times 6.3$$

$$S_R = 50.4 \text{ in.}$$

3. Work

  3.1 Introduce idea of work by having one boy lift a box and hand it to another boy who is told to stand and hold the box.

3.11 Ask if the boy who is holding the box was to hold it for two hours who would have done more work, the boy who lifted the box or the one holding the box?

3.12 Evolve the concept that work involves more than just exerting a force but that the force has to move over a distance.

3.2 Measuring work.

3.21 Work equals the product of the force applied and the distance the force moves.

3.22 Formula: $W = FxS$

where: W is the amount of work done.
F is the force applied.
S is the distance the force moves.

3.23 Units of work.
ft.-lb., in.-lb., joule (nt-m), erg (dyne-cm)

3.24 Examples:

3.241 How much work is done in lifting a 24 lb. box from the floor to a shelf 5 ft. high?

$W = 24 \text{ lb.} \times 5 \text{ ft.}$

$W = 120 \text{ ft.-lb.}$

3.242 How far would a force of 12 nt. have to be exerted in order to do 18 joules of work?

$18 \text{ joules} = 12 \text{ nt.} \times S$

$$S = \frac{18 \text{ joules}}{12 \text{ nt.}}$$

$S = 1.5 \text{ m}$

4. Assignment - Worksheet on mechanical advantage and work.

LESSON 4 - Power and Efficiency

1. Check over worksheet on mechanical advantage and work.

2. Power

2.1 Introduce power with the example of digging a ditch. Two men take four days digging by hand while a back hoe can do the same job in a few hours.

2.11 Who did the most useful work? (neither as the amount of material removed was the same.)

2.12 What was different? (The time which it took.)

2.2 Power is a measure of the rate at which work is done.

2.21 Expressed as a ratio of the work done to the time required to do the work.

Name________________________________ Date__________

Worksheet on Mechanical Advantage and Work.

1. Complete the following table.

F_R	F_E	S_R	S_E	MA_F	MA_S
50 lb.	10 lb.	2 ft.	10 ft.		
72 nt.		8 cm.	48 cm.	6	
10 dynes	40 dynes		5 cm.		4
	60 lb.	2 ft.	7.0 ft.	3.5	
12 nt.	120 nt.	4 m			10

2. Determine how much work is done when the following forces are exerted over the given distances.

Force	Distance	Work done
a. 12 lb.	6 ft.	
b. 65 nt.	2.5 m.	
c. 980 dynes	48 cm.	
d. 285 lb.	18 in.	
e. 75 nt.	6 m.	

3. How far would the following forces have to be exerted to do 288 joules of work?

a. 12 nt. ....
b. 144 nt. ....
c. 16 nt. ....
d. 72 nt. ....
e. 32 nt. ....
f. 288 nt. ....

4. How much force would have to be exerted over the following distances to do 576 ft. lb. of work.

a. 12 ft. ....
b. 8 ft. ....
c. 24 in. ....
d. 10 ft. ....
e. 24 ft. ....
f. 6 ft. ....

2.22 Equation: $P = \frac{W}{T}$

where: P is the power
W is the work done
T is the time required

2.23 Units

2.231 ft.-lb./sec., watt (joule/sec.), erg/sec.

2.232 Horsepower

2.2321 Power unit developed by James Watt to sell his steam engines.

2.2322 One horsepower is equal to 550 ft.-lb./sec.

2.2323 Equation: $Hp = P/550$ ft.-lb./sec.

but $P = \frac{W}{T}$

so: $Hp = \frac{W}{T \times 550 \text{ ft.-lb./sec.}}$

where: Hp is horsepower
W is work done
T is time required

2.24 Examples:

2.241 What power is required to lift 500 lb. of material a height of 20 ft. in 25 seconds?

$P = \frac{W}{T}$ but $W = F \times S$

so: $P = \frac{F \times S}{T}$

$P = \frac{500 \text{ lb.} \times 20 \text{ ft.}}{25 \text{ sec.}}$

$P = 400$ ft.-lb./sec.

2.242 What horsepower engine will be needed to lift 6,000 lb. of ore from a mine 600 ft. deep in 300 seconds?

$Hp = \frac{6{,}000 \text{ lb.} \times 600 \text{ ft.}}{300 \text{ sec.} \times 550 \text{ ft.-lb./sec.}}$

$Hp = 21.8$

3. Efficiency

3.1 To operate any machine force has to be used to overcome friction between parts and to lift parts of the machine.

3.2 This means that some of the work done on the machine is not gotten out of the machine as useful work.

3.3 Efficiency is the percentage of the work put into The machine that is gotten out as useful work.

3.4 Calculating efficiency

3.41 Formula: $\text{Eff.} = \frac{W_{out}}{W_{in}} \times 100\%$

where: Eff. is efficiency
W_{out} is output work
W_{in} is input work

3.42 Example: What is the efficiency of a machine which will produce 375 ft.-lb. of work when 400 ft.-lb. of work are put into it?

$$\text{Eff.} = \frac{375 \text{ ft.-lb.}}{400 \text{ ft.-lb.}} \times 100\%$$

$$\text{Eff.} = 93.8\%$$

4. Ideal and Actual Mechanical Advantages

4.1 If there was no need to overcome friction and exert force to move machine parts then the work output would equal the work input.

i.e. $W_{out} = W_{in}$

but $W = FS$

so $F_R \times S_R = F_E \times S_E$

where F_R is the resistance force, S_R is the resistance distance, F_E is the effort force and S_E is the effort distance.

then by algebra: $\frac{F_R}{F_E} = \frac{S_E}{S_R}$

4.2 Since force is required to operate the machine the ratio F_R/F_E does not equal the ratio S_E/S_R but is less.

4.21 The ratio F_R/F_E is called the actual mechanical advantage (AMA) because it represents the actual amount by which the force is increased.

4.22 The ratio S_E/S_R is called the ideal mechanical advantage (IMA) because it represents the amount the force should be increased if there were no losses.

5. Assignment - Worksheet on Mechanical Advantages, Power and Efficiency.

Name ______________________ Date ______________

Worksheet - Mechanical Advantage, Power and Efficiency

F_E	F_R	S_E	S_R	Time sec.	IMA_T	AMA_T	$Work_{in}$	$Work_{out}$	$Power_{in}$	$Power_{out}$	Eff.
10 lb.	50 lb.	12 ft.	2 ft.	5							
24 lb.	288 lb.	65 in.	5 in.	8							
10 lb.	2 lb.	5 in.	15 in.	0.5							
25 lb.	500 lb.	22 in.	1 in.	10							
18 lb.	144 lb.	2.5 ft.	3 in.	9							
20 lb.	8 oz.	2 in.	70 in.	5							
15 nt.	45 nt.	1.0 m.	0.25 m.	10							
80 dynes	5 dynes	3.0 cm.	45.0cm.	15							
300 dynes	25dynes	2.0 cm.	22.0cm.	5							
36 nt.	540 nt.	27 m.	1.5 m.	9							

LESSON 5 - Balance and Equilibrium

1. Review worksheet on mechanical advantages, power and efficiency.
2. Equilibrium
   The situation where there are no unbalanced forces acting on the object.
   - 2.2 Under these conditions the object may:
     - 2.21 Remain at rest.
     - 2.22 Continue to move in a straight line at a constant speed.
3. Torsional or rotational balance.
   - 3.1 Static balance
     - 3.11 The clockwise torques are equal to the counter-clockwise torques.
     - 3.12 The object remains in position.
     - 3.13 Applications
       - 3.131 Weighing an object with a laboratory balance.
       - 3.132 Balancing on a see-saw.
   - 3.2 Dynamic balance
     - 3.21 A statically balanced object may vibrate if it is rotated.
     - 3.22 This vibration will cause wear and uneven motion.
     - 3.23 The vibration will vary with the speed.
     - 3.24 In general rotating objects are balanced at the speed where they are most often operated.
     - 3.25 Examples:
       - 3.251 Rotors on turbines and motors.
       - 3.252 Dynamic wheel balancing on a car.
4. Center of Gravity
   - 4.1 Illustrate concept of center of gravity by balancing a meter stick on one finger and ask:
     - 4.11 What can be said about the torques operating on the stick? (Clockwise ones must be equal to the counterclockwise ones.)
     - 4.12 How much force must be exerted by the finger? (the weight of the stick.)
   - 4.2 Evolve the concept of center of gravity.
     - 4.21 That point where an object may be statically balanced regardless of the position in which it is placed.
     - 4.22 Or: That point where the weight of the object may be considered to be concentrated.
   - 4.3 Center of gravity in non uniform objects.
     - 4.31 Weight a meter stick at one end and locate the point of balance.

- 4.32 Have several sealed flat cardboard boxes which are weighted so their center of gravity is located in a corner, middle of the side, etc. These can then be stacked in rather odd manners.
- 4.33 Does the center of gravity have to be within the material of the object? Illustrate with a hollow cylinder or ring.

5. Stability
    - 5.1 An indication of the ability of an object to return to its original position after being tipped.
    - 5.2 Stable equilibrium
        - 5.21 Tipping the object causes the center of gravity to be raised.
        - 5.22 Examples:
            - 5.221 A book lying flat on a table.
            - 5.222 A chair.
    - 5.3 Unstable equilibrium
        - 5.31 Tipping the object causes the center of gravity to be lowered.
        - 5.32 Examples:
            - 5.321 A pencil balanced on its point.
            - 5.322 A man on a tight rope.
    - 5.4 Neutral equilibrium
        - 5.41 Tipping the object causes no change in the height of the center of gravity.
        - 5.42 Example: a ball.
    - 5.5 Increasing stability
        - 5.51 Increasing the area of the base.
            - 5.511 Legs of a chair slant outward.
            - 5.512 Spreading legs when standing in a bus or subway.
            - 5.513 Large bases on lamps.
        - 5.52 Lowering the center of gravity.
            - 5.521 Weighting the base of a lamp.
            - 5.522 Smaller diameter wheels on automobiles.
            - 5.523 Football linemen crouching in positions.

6. Assignment - Study for test on forces and their effects.

LESSON 6 - Vector Concept of a Force

1. Develop realization of the need for the vector expression of a force.
    - 1.1 Place a box on the table and ask what will happen when a force of 20 lb. is applied to the box.
    - 1.2 Question cannot be fully answered unless the direction of the force is known.

2. Scalar and vector quantities.
  2.1 Briefly review concept of scalar and vector quantities as developed in math class.
  2.2 Scalar quantities
    2.21 Require only magnitude to be fully expressed.
    2.22 Examples: volume, area, mass, speed, and density.

  2.3 Vector quantities
    2.31 Require a direction as well as magnitude.
    2.32 Examples: displacement, velocity and force.

3. Drawing force vector.
  3.1 A vector is an arrow which is a graphic representation of a vector quantity.
    3.11 Magnitude of the force is represented by the length of the arrow.
      3.111 Will need a scale to relate length to force size.
      3.112 A centimeter scale is most useful as it is divided in tenths.
      3.113 Example: Using a scale of 2 cm for every pound (2 cm = 1 lb.) determine the length of the arrow for each of the following forces.
      F = 2.5 lb.

$$\frac{x}{2.5\text{ lb.}} = \frac{2\text{ cm}}{1\text{ lb.}}$$

$$x = \frac{2.5\text{ lb.} \times 2\text{ cm}}{1\text{ lb.}}$$

$$x = 5.0\text{ cm}$$

F = 5.2 lb.

$$\frac{x}{5.2\text{ lb.}} = \frac{2\text{ cm}}{1\text{ lb.}}$$

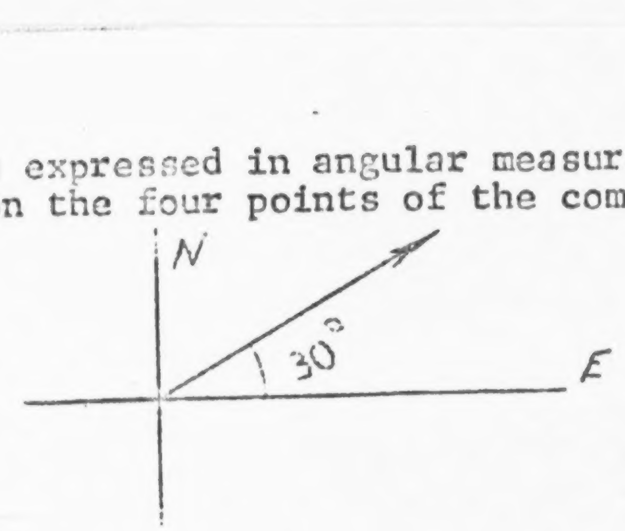
$$x = \frac{5.2\text{ lb.} \times 2\text{ cm}}{1\text{ lb.}}$$

$$x = 10.4\text{ cm}$$

    3.12 Direction of the force is represented by the direction the arrow is drawn from the point of application.
      3.121 Always represented as a pull on the point of application.

3.122 Direction is expressed in angular measurement based on the four points of the compass.

Example:



direction E 30° N
E is the starting or reference direction.
30° is the amount of rotation from the starting direction.
N is the direction of the rotation.
Note: may also be expressed as N 60° E.

4. Assignment - Worksheet on drawing force vectors.

LESSON 7 - The Resultant Vector

1. Review worksheet on drawing of force vectors.

2. Concept of a resultant force.
    - 2.1 Have two boys pull at right angles on a chair in which a third is seated.
    - 2.2 In what direction does the seated boy move? (Somewhere between the direction of the two forces.)
    - 2.3 Show that the same effect could be produced by one boy pulling in the direction of the movement of the seated boy.
    - 2.4 Resultant Force = that single force which produces the same affect as two or more forces.

3. Determining the resultant force. (Considerable work in math class on working with vectors precedes this work.)
    - 3.1 Forces acting in the same direction.
        - 3.11 Resultant is equal to the sum of the two forces.
        - 3.12 Direction of the resultant is the same as the two forces.
    - 3.2 Forces acting in opposite directions.
        - 3.21 Resultant is equal to the algebraic sum of the vectors.
        - 3.22 Direction of the resultant is the same as that of the largest vector.
    - 3.3 Forces acting at right angles.

Name________________________________ Date_____

Worksheet on Drawing Force Vectors.

1. On the given point P construct the following vectors. Use a scale of 1 lb. = 1 cm.

a) 8 lb. N	e) 3.0 lb. N 40°E
b) 2.4 lb. E	f) 7.2 lb. W 35°N
c) 6.8 lb. W	g) 5.8 lb. E 75°S
d) 4.3 lb. S	h) 6.3 lb. S 15°W

.P

Name____ Date_____

2. Construct the following vectors in order with the first one drawn from point A and using the head of each vector as the starting point for the next one. Use a scale of 8 lb. = 1 in.

a) 40 lb. E

b) 20 lb. S 60°W

c) 14 lb. S

d) 20 lb. S 30° E

e) 40 lb. W

f) 34 lb. N

A.

3.31 Resultant is greater than either of the forces but less than the sum of the forces.

3.32 Direction of the resultant is somewhere between the two forces.

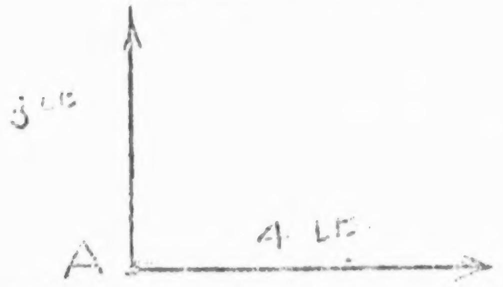
3.33 Graphic solution of vectors.

  3.331 Vectors, like geometric figures, may be moved about as long as the direction is not changed.

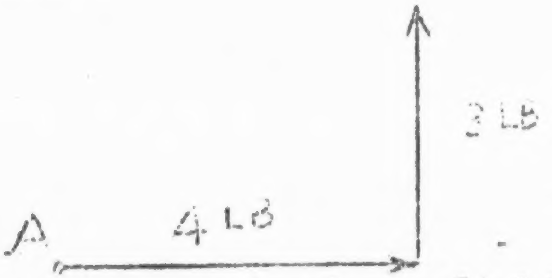
  3.332 Vectors are added by placing the tail of the second on the head of the first and the resultant is drawn from the tail of the first to the head of the second.

  Example: Find the resultant of two forces one 4 lb. acting E and the other 3 lb. acting N on point A.

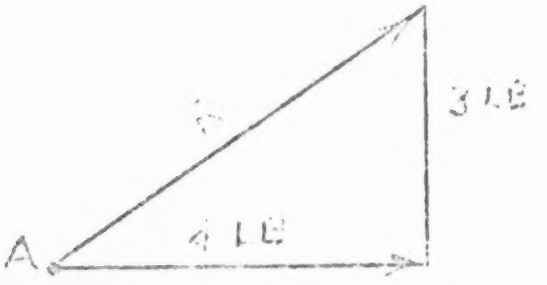
(1) Draw vectors using scale of 1 cm = 1 lb.



(2) Add the 3 lb. to the 4 lb. vector.



(3) Draw resultant (R)

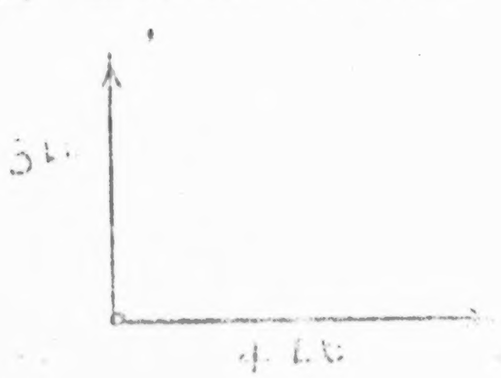


(4) Measure length of resultant R = 5 cm therefore is equal to 5 lb.
Measure angle between R and Easterly force. (with protractor)
angle equals 34.5°

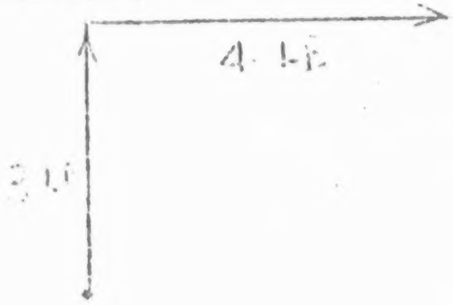
The resultant therefore is 5 lb. E 34.5° N

The same result may be obtained by adding the two vectors in the opposite order.

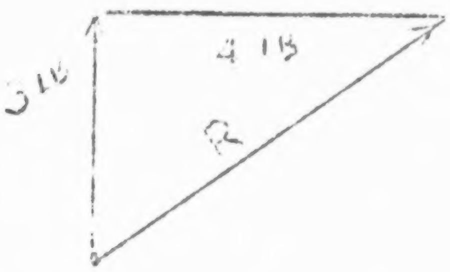
(1) Draw the vectors.



(2) Add the 4 lb. to the 3 lb. vector.



(3) Draw resultant (R)



(4) Measure length of resultant R = 5 cm therefore is equal to 5 lb.
Measure angle between R and Northerly Force.
angle equals 55.5°

The resultant therefore is 5 lb. N 55.5° E

Note from Lesson 6 part 3.122 we see that E 34.5° N is equivalent to N 55.5° E.

3.333 Show the group that by putting the two preceding solutions together that a parallelogram is formed and that the diagonal drawn from the point of application is the resultant.

3.34 Solution of vectors by computation.

3.341 From the diagrams drawn in 3.332 it can be seen that the resultant is the hypotenuse of a right triangle whose sides are the original forces.

3.342 To determine the magnitude of the resultant the Pythagorean Theorem is used.

i.e. $R^2 = F_E^2 + F_N^2$

where R is the resultant
F_E is the Easterly force

F_N is the Northerly force

so:
$$R^2 = (4 \text{ lb.})^2 + (3 \text{ lb.})^2$$
$$R^2 = 25 \text{ lb.}^2$$
$$R = 5 \text{ lb.}$$

3.343 To determine the direction of the resultant the trignometric function of the tangent will be used.

$$\text{Tan. } \theta = \frac{3 \text{ lb.}}{4 \text{ lb.}}$$

$$\text{Tan } \theta = 0.75$$
$$\theta = 34.5^\circ$$

so the resultant can be expressed as
5 lb. E 34.5° N.

4. Assignment - Worksheet on resultant vectors.

Name______________________________ Date______

Worksheet on Resultant Vectors.

For each vector set find the resultant by scale diagram and measuring the resultant, then solve it mathematically.

(1) 5 lb.N and 12 lb.E.

(2) 10 lb.S and 16 lb.W.

(3) 15 lb.S 30°W and 25 lb.N60°W

(4) 12 lb.E 15°N and 16 lb.S 15°E

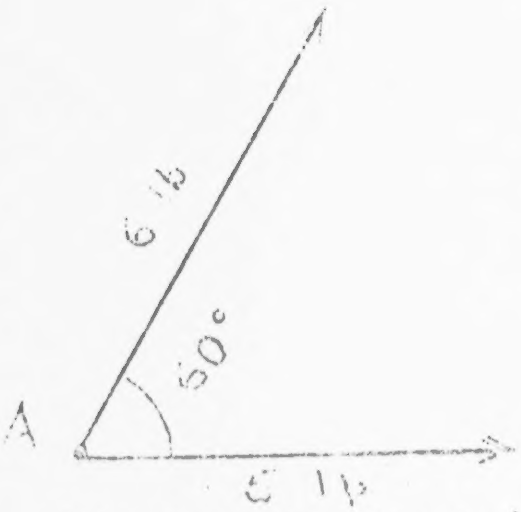
LESSON 8 - Resultant of Forces at other than Right Angles

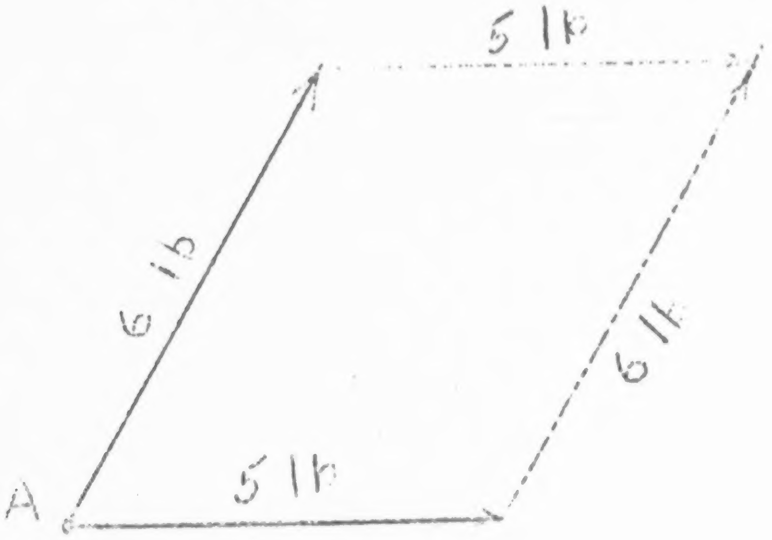
1. Review worksheet on resultant forces.

2. Resultant of forces acting at other than right angles.
   - 2.1 Graphic solution.
     - 2.11 A parallelogram is constructed using the force vectors as the sides of the parallelogram.
     - 2.12 The diagonal drawn from the point of application of the forces is then the resultant force.
     - 2.13 Example: A force of 5 lb. acts East upon point A and a force of 6 lb. acts E 60° N upon the same point. Find the resultant.

(1) Draw the vectors using a scale 1 cm = 1 lb.

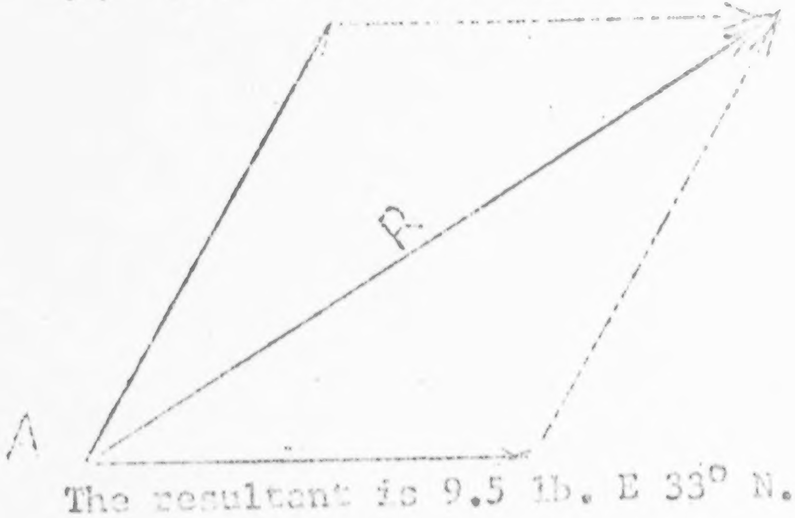
(2) Using a compass lay off length of 5 lb. vector at end of the 6 lb. one and lay off length of 6 lb. vector at end of 5 lb. one. Connect the intersection of these distances with dotted line to the ends of each vector.





(3) Draw Resultant (R)

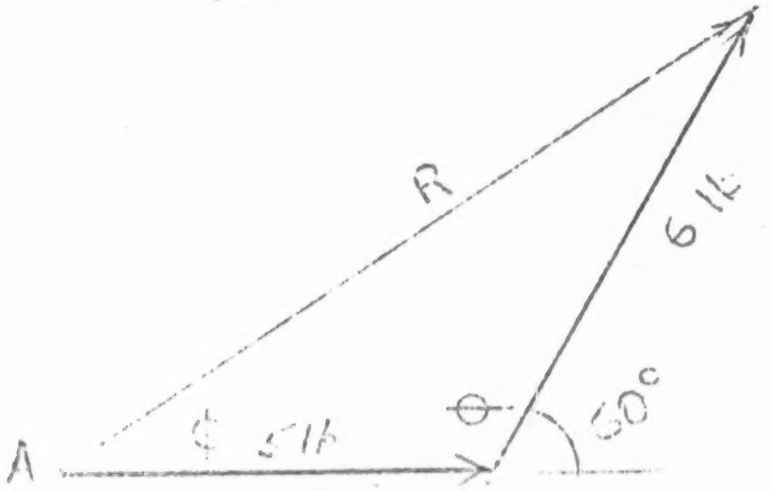
(4) Measure Resultant
R = 9.5 cm which is equal to 9.5 lb.
Measure angle between Easterly component and R.
angle equals 33°



The resultant is 9.5 lb. E 33° N.

2.2 Solution by computation.

2.21 A diagram is drawn similar in manner to those in Lesson 7 part 3.332.



2.22 Magnitude of R is calculated using the Law of Cosines.

$R^2 = F_1{}^2 + F_2{}^2 - 2F_1F_2\cos\theta$

where: R is the resultant
F_1 is one of the forces
F_2 is the other force

θ is the angle between the forces

so: $R^2 = (5\text{ lb.})^2 + (6\text{ lb.})^2 - 2(5\text{ lb.})\times(6\text{ lb.}) \times \cos.\ 120^\circ$

$R^2 = 25\text{ lb.}^2 + 36\text{ lb.}^2 - 60\text{ lb.}^2\ (-0.500)$
$R^2 = 91\text{ lb.}^2$
$R = 9.5\text{ lb.}$

2.23 Direction of the resultant is calculated by using the Law of Sines.

$$\frac{R}{\text{Sin }\theta} = \frac{6\text{ lb.}}{\text{Sin }\phi}$$

$$\text{Sin }\phi = \frac{0.866 \times 6\text{ lb.}}{9.5\text{ lb.}}$$

$\text{Sin }\phi = 0.5468$
$\phi = 33.1^\circ$

Resultant is 9.5 lb. E 33.1° N.

3. Pass out worksheets on composition of forces and spend remaining time working on these. The sheet is to be completed for homework.

Name________________________ Date______

Worksheet on composition of Forces.

Solve each of the following by making a vector diagram and then solve them mathematically.

1. Two forces act on point A. One is 18 lb. N, the other is 20 lb. S 25°E. What is the resultant?

2. The guy wires on a television antenna form an angle of 60° with each other and each is under a tension of 50 lb. How much force is pushing the antenna down?

3. The wire supporting a picture forms an angle of 120° at the nail driven into the wall. If the tension in the wire is 24 lb. how much force is exerted downward on the nail.

LESSON 9 - The Equilibrant Force and Resolutions of Forces

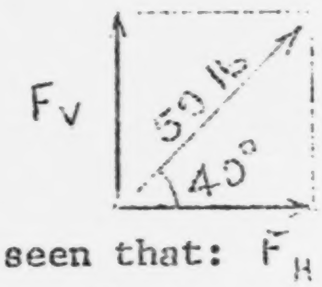
1. Review worksheet on composition of forces.

2. Equilibrant Force
   - 2.1 Review example from Lesson 7 section 2 of two boys pulling on a third boy who is seated in a chair.
   - 2.2 What would happen if the one boy who stepped in to replace the other two had exerted his force in the opposite direction and the original two had still been pulling? (No motion would occur.)
   - 2.3 Evolve concept of an equilibrant force.
     - 2.31 A force equal in magnitude but opposite in direction to the resultant force.
     - 2.32 The equilibrant produces the situation of equilibrium.

3. Resolution of Forces
   - 3.1 The separation of a single force into two component forces acting in specific directions, usually at right angles to each other.
   - 3.2 Applications
     - 3.21 Many times it is not convenient to apply the force in the direction desired so it will be applied at an angle.
     - 3.22 Pulling a slid or wagon.
     - 3.23 Pushing a lawn mower.
     - 3.24 Closing a window with a window pole.

   - 3.3 Determining the size of the component forces.
     - 3.31 The easiest solution is through the use of the trignometric functions of sine and cosine.
     - 3.32 Example: A boy pulls a loaded wagon with a force of 50 lb. If the handle forms an angle of 40° with the horizontal, what are the horizontal and vertical components of his force?

(1) Diagram the forces involved.



(2) From the diagram it can be seen that:

$$\sin 40^\circ = \frac{F_V}{50\text{ lb.}} \quad \text{and} \quad \cos 40^\circ = \frac{F_H}{50\text{ lb.}}$$

where F_V is the vertical component and F_H is the horizontal component.

(3) Solutions

$F_V = 50$ lb. x Sin 40° $\quad$ $F_H = 50$ lb. x cos 40°
$F_V = 50$ lb. x 0.643 $\quad$ $F_H = 50$ lb. x 0.766
$F_V = 32$ lb. $\quad$ $F_H = 38$ lb.

3.2 Resolving the force of gravity--the incline.

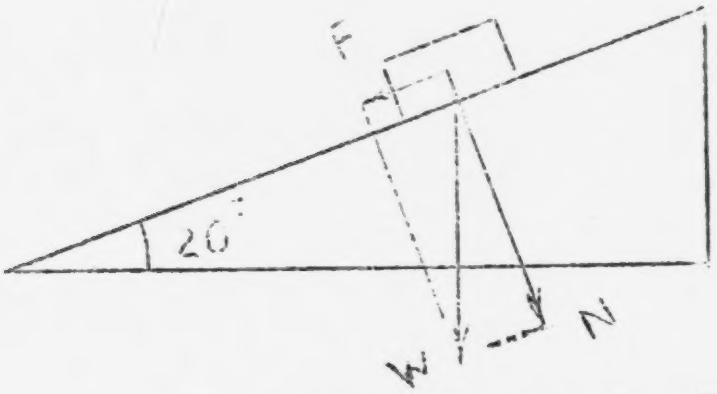
3.21 If an object is placed on an incline, the weight may be separated into two forces.

3.211 One acting parallel to the plane.

3.212 The other acting perpendicular to the plane. (The normal force.)

3.213 A box weighing 30 lb. is placed on a 20° incline. Determine the components of the weight acting down the plane and into the plane.

(1)



where: W is the weight of the box, N the component force perpendicular to the surface of the plane and F the component force parallel to the plane.

note: From the geometry of the diagram it can be shown that the angle of incline and the angle formed by N and W are equal.

(2) Solution

$\sin 20^\circ = \frac{F}{W}$ $\qquad$ $\cos 20^\circ = \frac{N}{W}$

$F = W \sin 20^\circ$ $\qquad$ $N = W \cos 20^\circ$

$F = 30$ lb. x 0.342 $\qquad$ $N = 30$ lb. x 0.940

$F = 10$ lb. $\qquad$ $N = 28$ lb.

3.22 An interesting illustration is the following:

3.221 A cart used for inclined plane experiments (Hall's carriage) is loaded so that its mass is 1 kg.

3.222 The cart is to be placed on a 30° incline.

3.223 Calculate in the manner of 3.213 the components of the kg. weight.
F = 500 g., N = 866 g.

3.224 Apply these amounts of force to the cart in the opposite direction to which the components are acting. (Strings attached to the cart and run over pulleys attached to instrument supports. The forces are developed by using laboratory weights hung on the strings.)

3.225 Since the two applied forces exactly cancel the components of the weights of the cart, there should be no need for the incline. Remove it and the cart remains in position.

4. Assignment - Worksheet on resolution of forces.

LESSON 10 - Review of Work on Forces

1. Go over in detail the worksheet on Resolution of Forces.

2. As additional aid and review have the students present selected exercises from the worksheets for lessons 6 - 9 to the class.

3. Assignment - Study for test on forces.

LESSON 11 - Simple Machines - The Lever

1. Review basic machine concepts as developed in Lessons 3 and 4.
   1.1 Purposes of a machine.
      1.11 Increase force.
      1.12 Increase speed or distance.
      1.13 Change direction.

   1.2 A machine cannot increase the amount of work done.
   1.3 Mechanical Advantage - Ideal, Actual, Methods of determining, etc.

2. The lever.
   2.1 Characteristics
      2.11 A rigid bar which is free to rotate about a fixed point.
      2.12 Parts of a lever.
         2.121 Fulcrum - point about which the bar rotates.
         2.122 Effort arm - distance from point of application of the effort force to the fulcrum.
         2.123 Resistance arm - distance from point of application of the resistance force to the fulcrum.

Name______________________________ Date______

Worksheet on Resolution of Forces.

For each problem make a scale diagram and solve mathematically.

1. A boy pulls a wagon with a force of 15 lb. If the handle forms an angle of 20° with the ground find the horizontal and vertical components of his force.

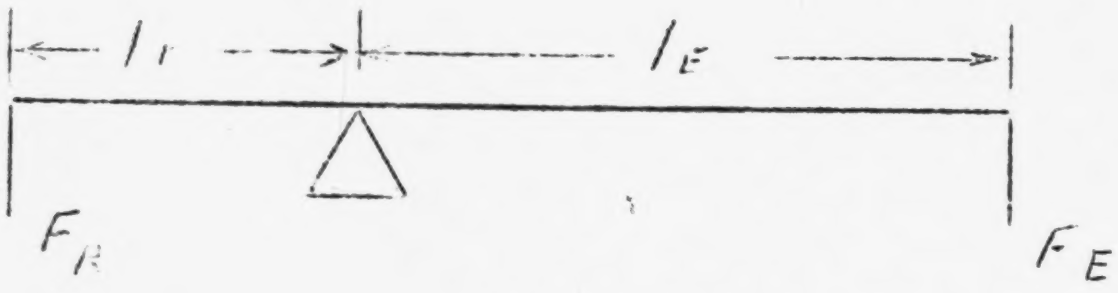
2. A force of 30 lb. is exerted on a window pole to close the window. If the pole forms an angle of 15° with the window how much force is closing the window and how much is trying to push the window out?

3. A force of 230 nt acts N 60°E. What are the N and E components of this force.

4. A 500 lb. box rests on an incline which forms an angle of 18° with the ground. What are the components of the box's weight parallel and perpendicular to the plane?

5. How much force will be needed to hold a 600 lb. safe on an inclin whose angle is 12 degrees?

2.124 Diagram



where l_R is the resistance arm and l_E is the effort arm.

2.2 Mechanical advantage of a lever.

- 2.21 If the lever is considered weightless and without friction a simple torque analyses can be applied.
  i.e. $F_R \times l_R = F_E \times l_E$
- 2.22 By algebraic manipulation:

$$\frac{F_R}{F_E} = \frac{l_E}{l_R}$$

- 2.23 From section 1 it can be seen that the ratio F_R/F_E is the actual mechanical advantage.
- 2.24 In practice the two ratios in 2.22 are not equivalent but l_E/l_R will be larger and is referred to as the ideal mechanical advantage.

2.3 Classes of lever.

- 2.31 First class lever.
  - 2.311 The fulcrum is between the effort and the resistance.
  - 2.312 Can be used to increase force.
    - 2.3121 When effort arm is longer then resistance arm.
    - 2.3122 Examples - Claw hammer pulling out a nail
      A pair of tin snips
  - 2.313 Can be used to increase speed or distance.
    - 2.3131 Where effort arm is shorter than resistance arm.
    - 2.3132 Example - pair of paper shears.
- 2.32 Second class lever.
  - 2.321 The resistance is between the effort and the fulcrum.
  - 2.322 Used only to multiply force as the effort arm is always longer than the resistance arm.
  - 2.323 Examples: wheelbarrow and nutcracker.

2.33 Third class lever.
  2.331 The effort is between the resistance and the fulcrum.
  2.332 Used only to multiply speed or distance as the effort arm is always less than the resistance arm.
  2.333 Examples: tweezers and ice tongs.

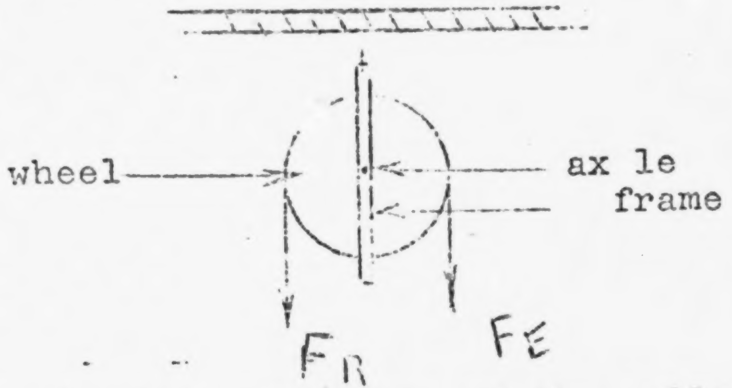
3. Assignment - Worksheet on levers.

LESSON 12 - Simple Machines - The Pulley

1. Review worksheet on levers.

2. A pulley is a wheel which is free to turn about an axle which is mounted in a frame.

3. Fixed pulley.
  3.1 The pulley does not move up or down as the load is moved.
  3.2 Diagram



  3.3 Mechanical advantage of the pulley.
    3.31 Can be likened to a lever.
      3.311 Fulcrum is the axle.
      3.312 Since the rope is over the edge of the wheel the effort and resistance arms are radii of the wheel and are equal.

    3.32 The mechanical advantage is thus one.
    3.33 The pulley is used to change direction of the force but ideally does not change the size of the force.

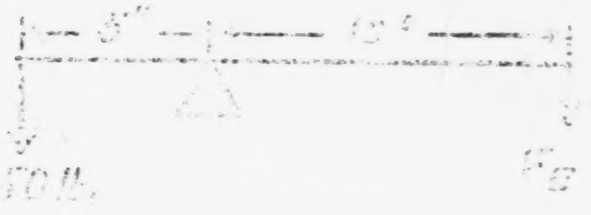
4. Movable pulley.
  4.1 The pulley moves up and down with the load. One end of the rope is fixed in place and the load is attached to the frame.

Name________________________ Date______________

P.S. Physics - Worksheet on Levers.

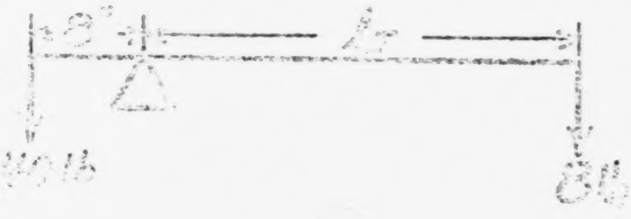
Compute the missing value for each of the following - Disregard the weight of the lever.

1.



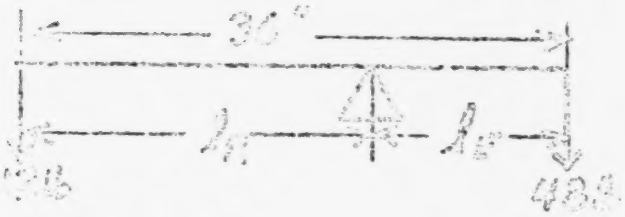
F_E = ________

2.


8"
l_E
40 lb
8 lb

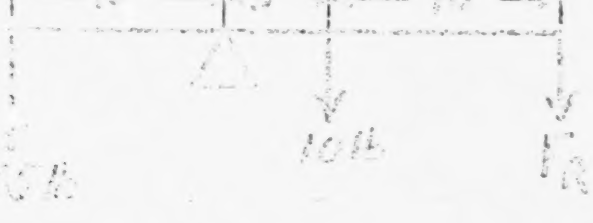
l_E = ________

3.


36"
l_R
l_E
48 lb

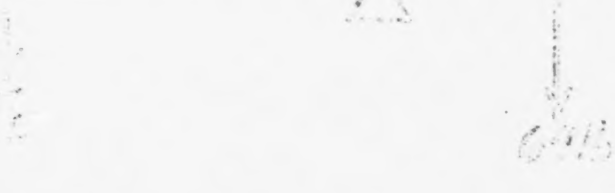
l_R = ________ l_E = ________

4.


10"
5"
10"
10 lb
F_R

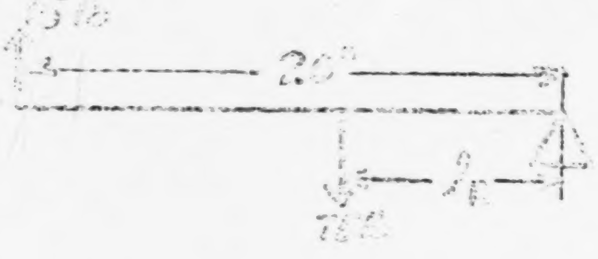
F_R = ________

5.



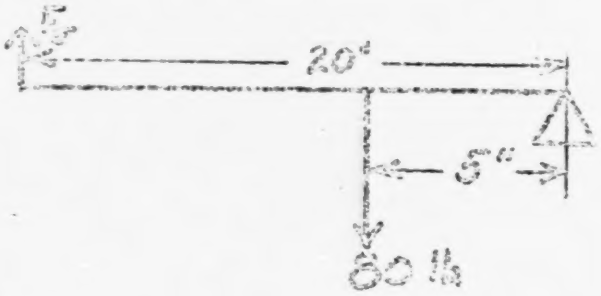
F_E = ________

6.



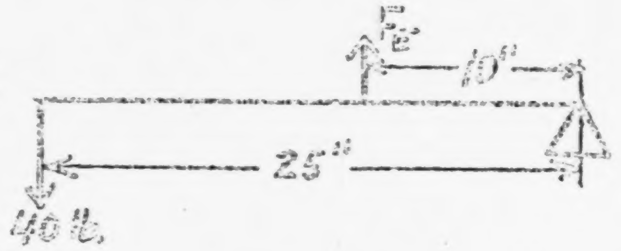
l_R = ________

7.



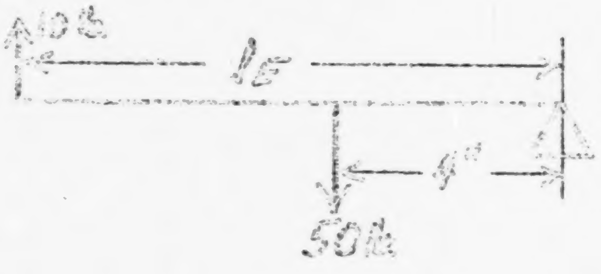
F_E = ________

8.


F_E
10"
25"
40 lb.

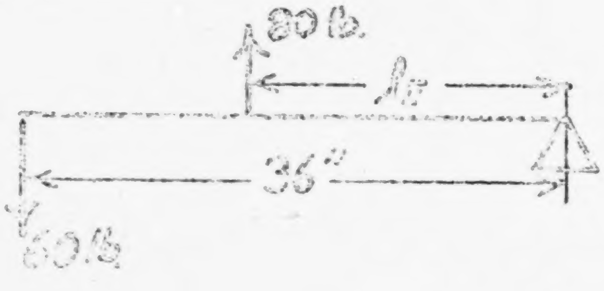
F_E = ________

9.


10 lb
l_E
4"
50 lb

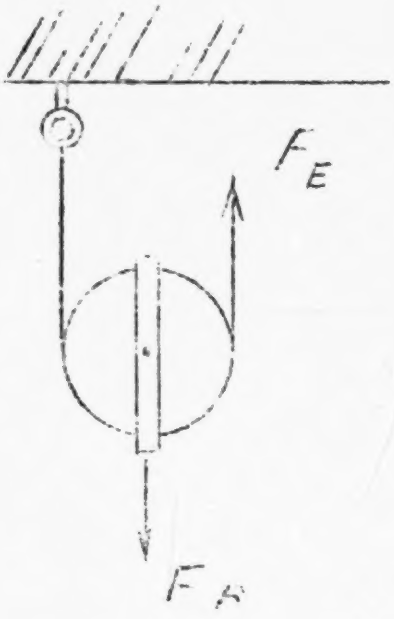
l_E = ________

10.


80 lb.
l_E
36"
60 lb.

l_E = ________

4.2 Diagram

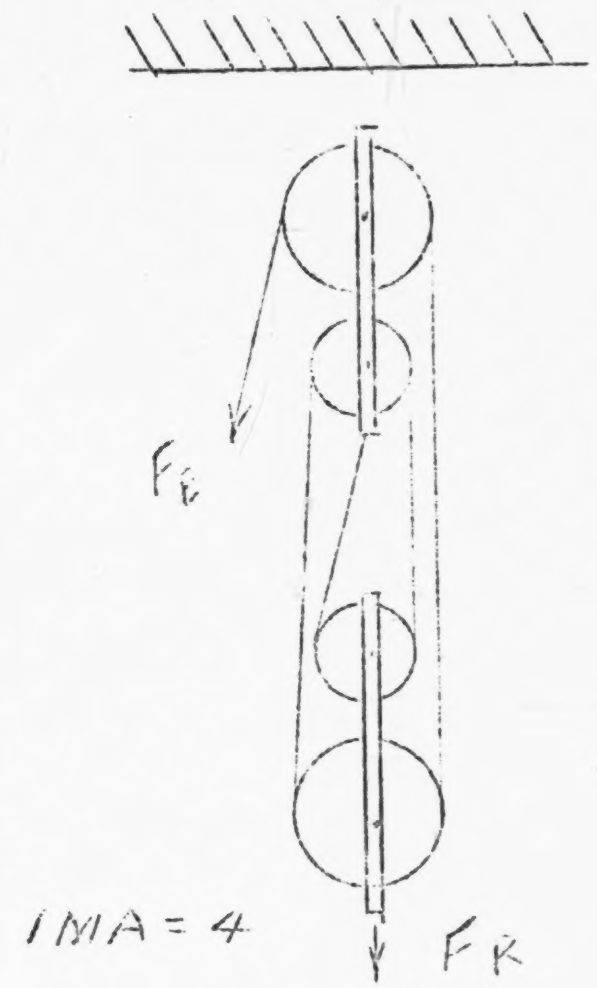


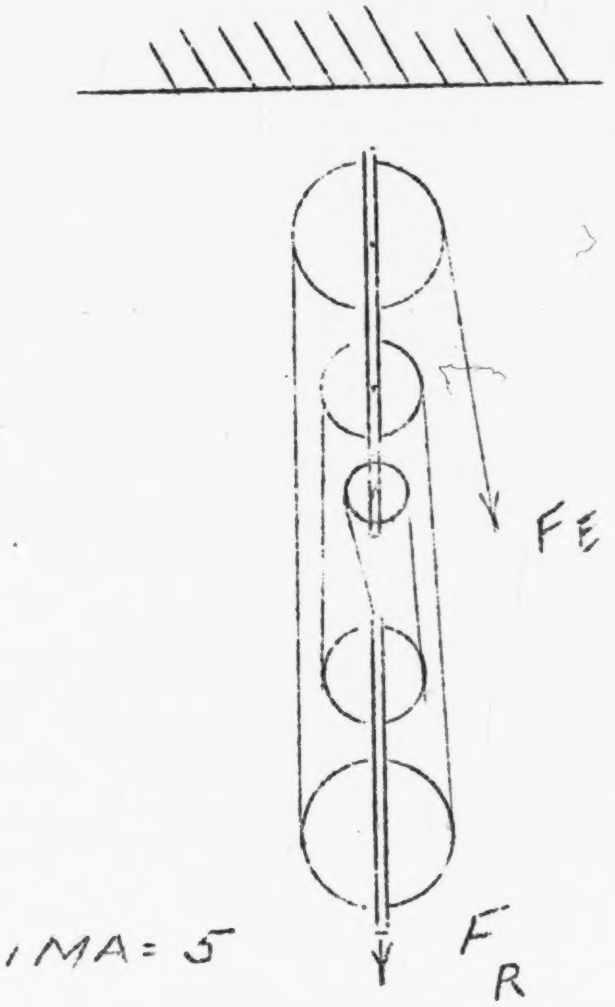
4.3 Mechanical advantage of the pulley.
    4.31 Can again be likened to a lever.
        4.311 The fulcrum is now the point of contact with the fixed rope.
        4.312 Effort arm will be the diameter of the pulley, while the resistance arm is the radius of the pulley.
        4.313 The ideal mechanical advantage is therefore two.
            4.3131 In order to move the resistance up a unit distance the effort force must move twice as far.
            4.3132 A simple way of determining the I.M.A. is by counting the number of ropes supporting the movable pulley.

5. Pulley combinations.
    5.1 Frequently refered to as a block and tackle.
    5.2 Consists of several wheels on a common axle in a single frame.
        5.21 Two sets are used, one fixed and the other movable.
        5.22 Individual wheels are called sheaves.

    5.3 Ideal mechanical advantage is determined by the number of ropes supporting the movable set.

5.4 Examples:



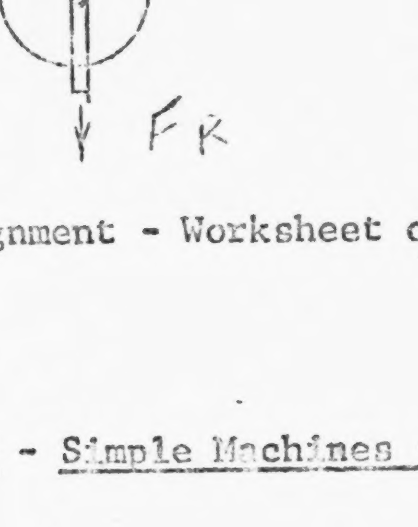


6. Assignment - Worksheet on pulleys.

LESSON 13 - Simple Machines - Wheel and Axle

1. Review worksheet on the pulley.

2. Wheel and axle.
   2.1 A wheel or "crank rigidly" attached to an axle.
   2.2 May be considered a lever with unequal arms.
   2.3 Diagram



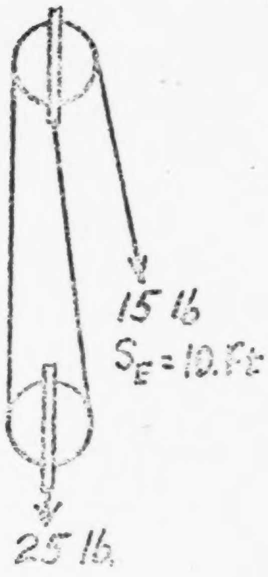
where: r_S is radius of the small wheel or axle.
r_L is radius of the large wheel or crank.

Name______________________________ Date______________

Worksheet - Pulley

Determine for each pulley system the I.M.A., Resistance Distance, Work Input, Work output and efficiency.

(1)


15 lb
S_E = 10 ft
25 lb

IMA = ...

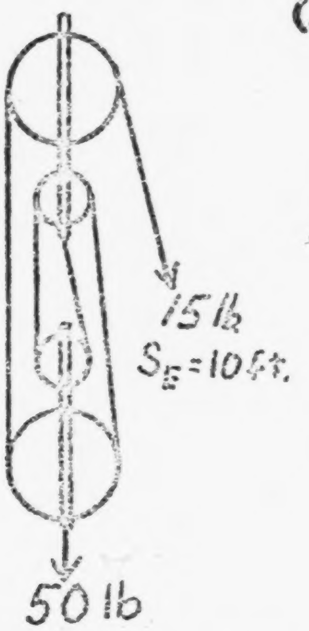
S_R = ...

W_{IN} = ...

W_{OUT} = ...

Eff. = ...

(2)


15 lb
S_E = 10 ft.
50 lb

IMA = ...

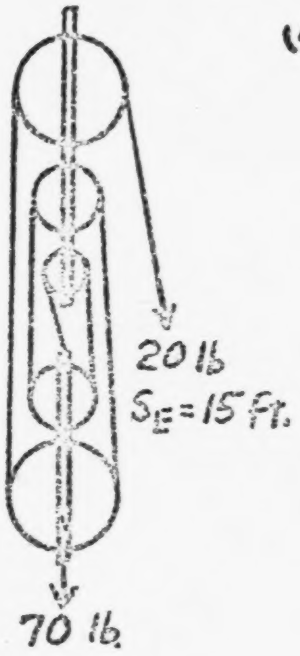
S_R = ...

W_{IN} = ...

W_{OUT} = ...

Eff. = ...

(3)


20 lb
S_E = 15 ft.
70 lb.

IMA = ...

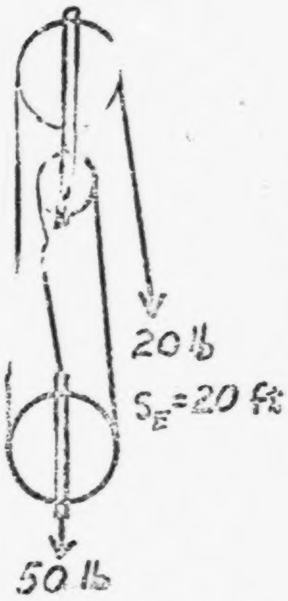
S_R = ...

W_{IN} = ...

W_{OUT} = ...

Eff. = ...

(4)


20 lb
S_E = 20 ft
50 lb

IMA = ...

S_R = ...

W_{IN} = ...

W_{OUT} = ...

Eff. = ...

5. The maximum effort force that a man can exert is 150 lb. For each of the following resistances draw a pulley system which could lift that resistance without exceeding the effort force.

a) 450 lb. b) 900 lb. c) 300 lb.

d) 700 lb. e) 500 lb.

2.4 In one turn of the wheel:

2.41 F_E will move down a distance equal to the circumference of the large wheel ($2\pi r_L$)

2.42 F_R will move up a distance equal to the circumference of the small wheel ($2\pi r_S$)

2.5 Ideal mechanical advantage of wheel and axle.

2.51 From general definition $\text{IMA} = \dfrac{S_E}{S_R}$

2.52 S_E equals circumference of the large wheel and S_R equals circumference of the small wheel.

2.53 So: $\text{IMA} = \dfrac{2\pi r_L}{2\pi r_S}$

2.54 Simplifying: $\text{IMA} = \dfrac{r_L}{r_S}$

2.6 Applications

2.61 For gaining force.

2.611 Steering wheel on a car.

2.612 Crank on lifting device of a tow truck.

2.613 Vise handles.

2.62 For gaining speed.

2.621 Step-cone pulleys on drill press.

2.622 Adjustable diameter pulley on fan motor for air circulating system.

2.7 Sample problems.

2.71 What is the ideal mechanical advantage of a winch which has a handle 30 in. long attached to a drum 3 in. in diameter?

$\text{IMA} = \dfrac{r_L}{r_S}$ where r_L = 30 in. and

$r_S = \dfrac{3 \text{ in.}}{2}$ (3 in. is the diameter and diameter=2r)

$$\text{so: } \text{IMA} = \frac{30 \text{ in.}}{1.5 \text{ in.}}$$

$$\text{IMA} = 20$$

2.72 Two step-cone pulleys are to be used to provide variable speeds for a machine tool. Both pulleys sets are the same size. The diameters of the pulleys are 2 in., 3 in. and 4 in. For each possible combination determine the speed ratio of driven pulley to the driving pulley.

(1) Possible combinations.

Driving Pulley	Driven Pulley
2 in.	2 in.
2 in.	3 in.
2 in.	4 in.
3 in.	2 in.
3 in.	3 in.
3 in.	4 in.
4 in.	3 in.
4 in.	2 in.

It is obvious that when both diameters are the same, there is no speed change.

i.e. speed ratio = 1

(2) Speed ratio will equal the ratio of the circumference of the driving pulley to that of the driven pulley.

i.e. $$S.R. = \frac{C_2}{C_1}$$

where: S.R. is the speed ratio, C_1 is the circumference of the driven pulley and C_2 is the circumference of the driving pulley.

but: $C_1 = \pi d_1$ and $C_2 = \pi d_2$ where d is the diameter of the pulley.

so: $$S.R. = \frac{d_2}{d_1}$$

(3) Solution

Driving Pulley (d_2)	Driven Pulley (d_2)	S.R.
2 in.	3 in.	0.67
2 in.	4 in.	0.50
3 in.	2 in.	1.50
3 in.	4 in.	0.75
4 in.	2 in.	2.00
4 in.	3 in.	1.33

Obtained by formula.

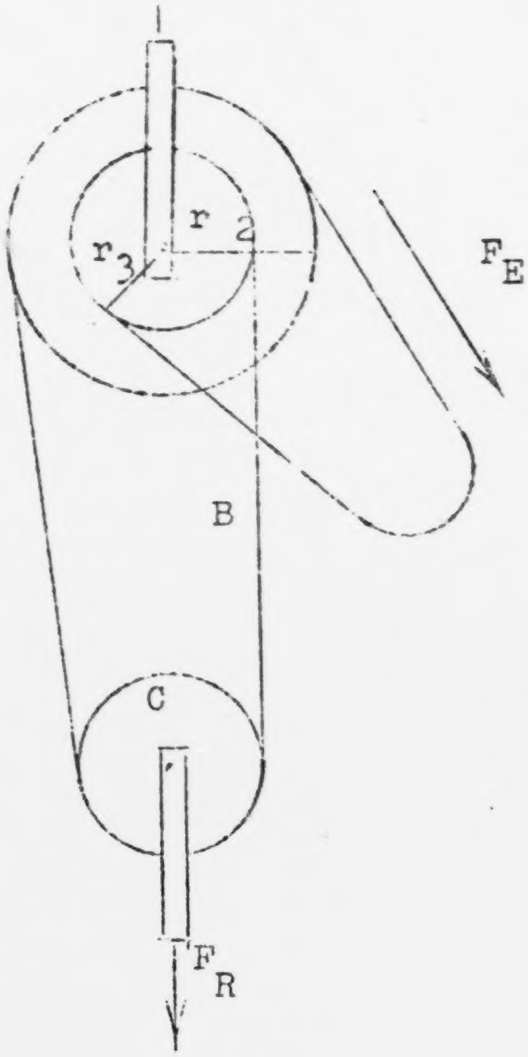
$$S.R. = \frac{d_2}{d_1}$$

so: $$S.R. = \frac{2\text{ in.}}{3\text{ in.}}$$

$$S.R. = 0.67$$

3. The differiential pulley.
   3.1 A combination of the wheel and axle and a movable pulley.

3.2 Diagram



3.3 For one turn of the large wheel F_E will move a distance equal to the circumference of the large wheel or $S_E = 2\pi r_L$

3.4 Rope section A will be pulled up an equal distance $(2\pi r_L)$

3.5 Rope section B will be increased by a distance equal to the circumference of the small wheel $(2\pi r_S)$

3.6 The rope supporting the movable pulley C will thus be shortened by the difference in the two length changes. $(2\pi r_L - 2\pi r_S)$

3.7 F_R will thus move up a distance equal to half the length decreased or $S_R = \frac{1}{2}(2\pi r_S)$

3.8 Ideal mechanical advantage will equal the ratio of these two distances.

$$\text{or} \quad IMA = \frac{2\pi r_L}{\frac{1}{2}(2\pi r_L - 2\pi r_S)}$$

simplifying

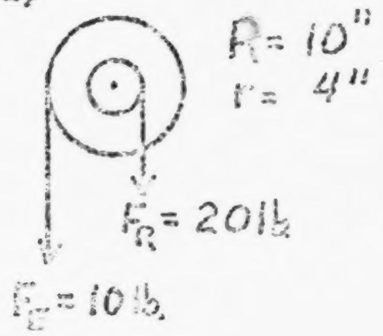
$$IMA = \frac{2r_L}{r_L - r_S}$$

4. Assignment - Worksheet on wheel and axle.

Name________________________________ Date________________

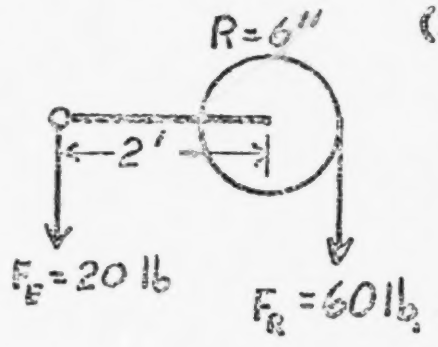
Worksheet - Wheel and Axle

(1)



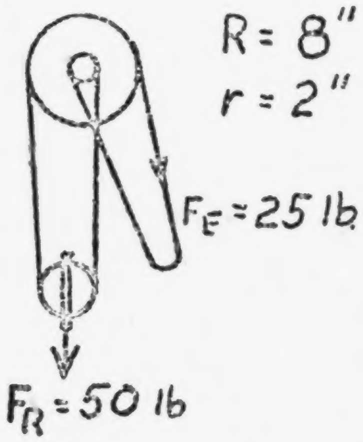
R = 10"
r = 4"
F_R = 20 lb
F_E = 10 lb

(2)



R = 6"
2'
F_E = 20 lb
F_R = 60 lb

(3)



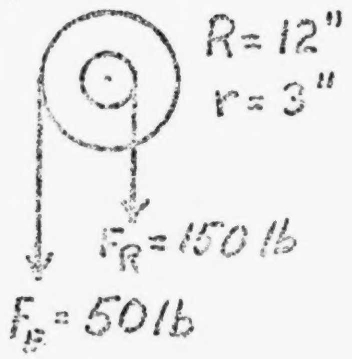
R = 8"
r = 2"
F_E = 25 lb
F_R = 50 lb

IMA = ...
AMA = ...
Eff.= ....

IMA = ...
AMA = ...
Eff.= ....

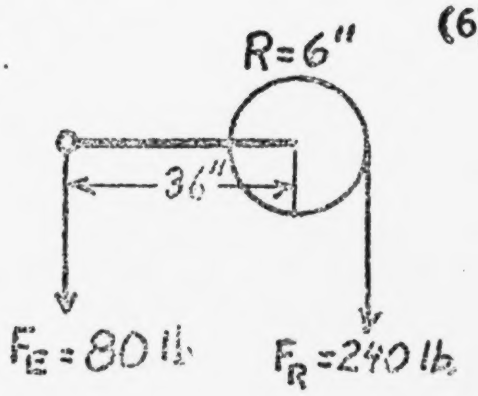
IMA = ...
AMA = ...
Eff.= ....

(4)



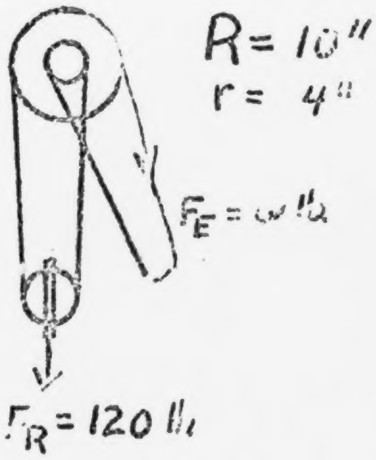
R = 12"
r = 3"
F_R = 150 lb
F_E = 50 lb

(5)



R = 6"
36"
F_E = 80 lb
F_R = 240 lb

(6)



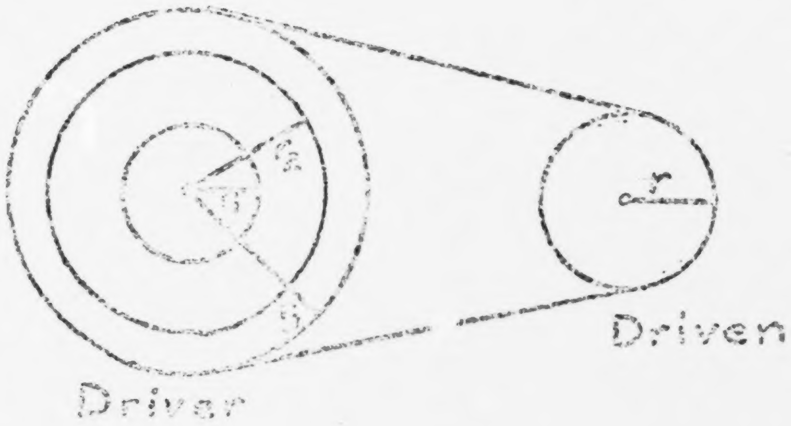
R = 10"
r = 4"
F_E = [illegible] lb
F_R = 120 lb

IMA = ...
AMA = ...
Eff.= ....

IMA = ...
AMA = ...
Eff.= ....

IMA = ...
AMA = ...
Eff.= ....

(7)


r_2
r_1
r_3
r
Driven
Driver

r_1 = 2 in.

r_2 = 4 in.

r_3 = 6 in.

r = 3 in.

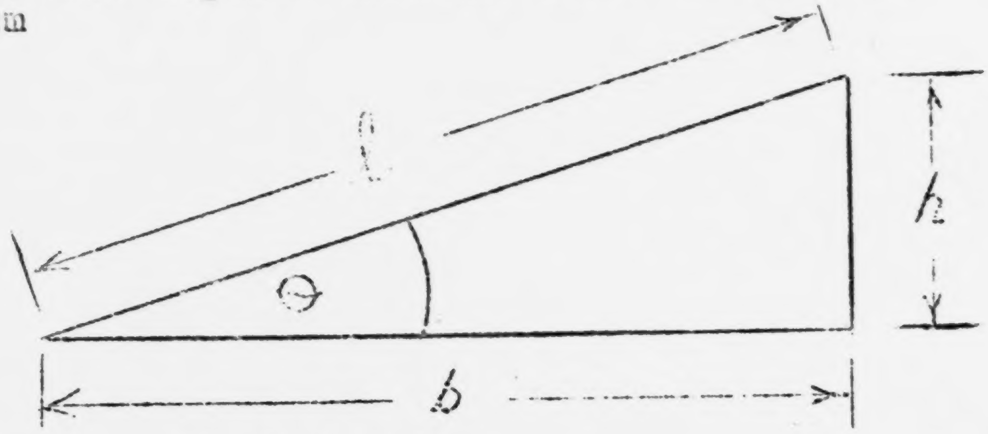
What is the speed ratio for the 3 possible combinations?

Driver	Driven	S.R.
2 in.	3 in.	....
4 in.	3 in.	....
6 in.	3 in.	....

LESSON 14 - Simple Machines - Inclined Plane

1. Check over worksheet on wheel and axle.

2. The inclined plane.
   - 2.1 A flat surface one end of which is higher than the other.
   - 2.2 Used to lift objects from one level to another.
   - 2.3 Diagram



l is the length of the plane
h is the height of the plane
b is the base of the plane
θ is the angle of the incline

2.4 In lesson 9 section 3.2 the basic principles of the inclined plane were developed.
- 2.41 By moving the load through a distance l it can be raised to a height h.
- 2.42 The plane supports part of the weight so the effort needed is only that to overcome the component which is acting parallel to l.
- 2.43 It was shown in lesson 9 part 3.2 that the force down the plane was equal to the weight times the sin θ.
- 2.44 The sin θ is equal to the ratio of h to l.
- 2.45 So: $F = W \times \frac{h}{l}$

  or: $F \times l = W \times h$

2.5 The purpose of the inclined plane is thus to lift a weight W to a height h by exerting a force F through a distance l.

2.6 From 2.45 the following can be evolved:
- 2.61 $\frac{W}{F} = \frac{l}{h}$
- 2.62 In actual experience these two ratios will not be equal as the actual value for F will include the force necessary to overcome friction.
- 2.63 The l/h ratio will provide the ideal mechanical advantage.

3. Sample problem.

3.1 A 500 lb. safe is rolled up a plank 15 ft. long to a platform 3 ft. high. What is the IMA of the plane?

$$\text{IMA} = \frac{15 \text{ ft.}}{3 \text{ ft.}}$$

$$\text{IMA} = 5$$

3.2 Neglecting friction, how much force would be needed? if there is no friction IMA = AMA

$$\text{and } \frac{W}{F} = \text{IMA}$$

$$\text{so: } \frac{500 \text{ lb.}}{F} = 5$$

$$F = \frac{500 \text{ lb.}}{F}$$

$$F = 100 \text{ lb.}$$

3.3 If the force necessary was actually 125 lb., what is the AMA of the plane?

$$\text{AMA} = \frac{500 \text{ lb.}}{125 \text{ lb.}}$$

$$\text{AMA} = 4$$

3.4 How much work was put into the machine?

$W_{in} = F_E \times S_E$ which for the inclined plane becomes: $W_{in} = F \times l$

$$\text{so: } W_{in} = 125 \text{ lb.} \times 15 \text{ ft.}$$

$$W_{in} = 1875 \text{ ft.-lb.}$$

3.5 What is the work output?

$W_{out} = F_R \times S_R$ which for the inclined plane becomes $W_{out} = W \times h$

$$\text{so: } W_{out} = 500 \text{ lb.} \times 3 \text{ ft.}$$

$$W_{out} = 1500 \text{ ft.-lb.}$$

3.6 What is the efficiency of this machine?

$$\text{Eff.} = \frac{W_{out}}{W_{in}} \times 100\%$$

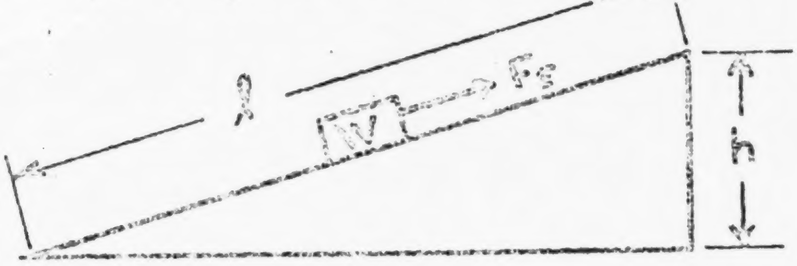
$$\text{Eff.} = \frac{1500 \text{ ft.-lb.}}{1875 \text{ ft.-lb.}} \times 100\%$$

$$\text{Eff.} = 80\%$$

4. Assignment - Worksheet on inclined plane.

Name______________________________ Date________________

I.P. Physics Worksheet - Inclined Plane



Factors in relationship to general terms.

$F_R = W$ $S_E = l$ $S_R = h$

Complete table - Set up relationships and solve on a separate sheet of paper - place answers in appropriate spaces.

l	h	F_R	F_E	IMA	AMA	$Work_{in}$	$Work_{out}$	Efficiency
6 ft.	2 ft.	125 lb.	50 lb.					
8 ft.	1 ft.		70 lb.		6			
10 ft.	2 ft.	300 lb.			3			
	3 ft.	360 lb.	90 lb.	5				
12 ft.		150 lb.	75 lb.	3				

On a separate sheet of paper set up a diagram of each problem and solve it in a neat and orderly manner.

1. A 250 lb. barrel is rolled up a plank 8 ft. long into a truck 4 ft. high. How much effort is required if friction is neglected?

2. A man can exert a force of 100 lb. and has to load a 300 lb. weight into a truck 3 ft. high. How long a plank will he need if the friction is eliminated by using rollers?

3. A yacht weighing 2 tons is to be loaded into a truck 4 ft. high by means of planks 20 ft. long. Neglecting friction, what force must be exerted parallel to the planks in order to move the yacht?

4. An inclined plane 15 ft. long is needed to raise a 1000 lb. weight onto a platform with an effort of 200 lb. Neglecting friction, how high is the platform?

5. Assuming no friction, how heavy a safe can be loaded into a truck 5 ft. high by an effort of 500 lb. if a set of planks 20 ft. long are used?

LESSON 15 - Simple Machines - The Wedge and Screw.

1. Review worksheet on inclined plane.

2. The Wedge
   2.1 An application of the inclined plane.
      2.11 The inclined plane generally is a fixed machine.
      2.12 The wedge is a movable inclined plane.

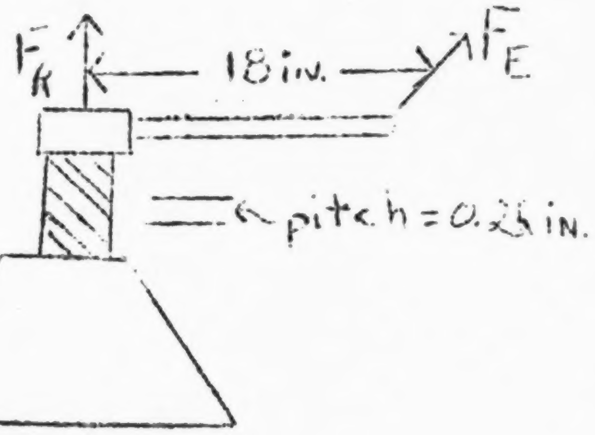
   2.2 Effort force is applied to the vertical edge of the wedge.
   2.3 Effort distance becomes the length of the base.
   2.4 Resistance force and resistance distance are still the same.
   2.5 Ideal mechanical advantage of the wedge is the ratio of the base to the height.
   i.e. $IMA = \frac{b}{h}$
   2.6 The efficiency of the wedge is generally low as there is a considerable amount of friction involved.
   2.7 Applications of a wedge.
      2.71 As a separating device.
         2.711 Splitting logs.
         2.712 Teeth on saw blade.
         2.713 An axe.

      2.72 As a holding device.
         2.721 Simple door stop.
         2.722 Quoines for holding printing type in the frame.
         2.723 Taper pins for holding wheels on shafts.

3. Screw
   3.1 Basically an inclined plane which has been wound around a cylinder.
   3.2 Pitch of a screw.
      3.21 The distance between the threads.
      3.22 The distance the screw will move in one complete turn.

   3.3 Mechanical advantage of a screw.
      3.31 Resistance distance will be the pitch of the screw.
      3.32 Effort distance will be the circumference of the circle around which the effort force will move.
      3.33 Example: A jack screw has a pitch of 0.25 in. and the handle is 18 in. long. What is the IMA?

(1) Diagram



(2) $S_E = 2\pi 18$ in.
$S_R = 0.25$ in.

(3) $$\text{IMA} = \frac{S_E}{S_R}$$

$$\text{IMA} = \frac{2\pi 18\ \text{in.}}{0.25\ \text{in.}}$$

$$\text{IMA} = 450$$

3.4 Efficiency of a screw.
3.41 There is a lot of friction involved due to the amount of surface in contact and the large resistance force.
3.42 The efficiency is generally low but is offset by the high mechanical advantage.

3.5 Uses of a screw.
3.51 Transmitting motion.
3.511 Can change circular motion to linear motion.
3.512 For every turn of the screw a linear motion equal to the pitch is produced.
3.513 Used as lead and feed screw machine tools.

3.52 Making adjustments and measurements.
a
3.521 Since the large turning radius can produce a small linear motion the screw is useful in making fine adjustments.
3.522 Screws are used for leveling instruments, adjusting measuring devices, etc.
3.523 If a graduated collar is attached to the screw it can be used for fine measurements.
3.524 Screws are used in this manner in micrometers and various other measuring devices on machine tools.

3.53 As fastening devices
    3.531 Screw thread can act as a wedge and thus provide a high degree of holding power.
    3.532 Wood screws provide much greater holding power than an ordinary nail.
    3.533 Machine bolts are widely used for many holding jobs.

3.54 Transmitting force with a screw.
    3.541 The jackscrew in 3.33 is an explanation of this use.
    3.542 Jackscrews are used in many areas.
        3.5421 Certain types of automotive jacks.
        3.5422 Heavy duty jacks for lifting large loads such as buildings.

4. Assignment - Worksheet on the wedge and screw.

LESSON 16 - Gears and Gear Trains

1. Review worksheet on wedge and screw.

2. What are gears?
    2.1 Rotating cylinders on cones with projecting teeth that mesh with one another so that there is a positive drive.
    2.2 Types of gears.
        2.21 Spur
            2.211 Cylinders with teeth on their surfaces.
            2.212 Used to drive shafts in parallel.

        2.22 Bevel gears.
            2.221 Cones with teeth on their surfaces.
            2.222 Used to drive shafts at an angle to each other, generally at right angles.

        2.23 Helical gears.
            2.231 Similar to spur gears.
            2.232 Teeth are not parallel with the shaft.
            2.233 Teeth are in the form of a helix across the surface.
            2.234 May be operated at any angle to each other.

        2.24 Worm gear.
            2.241 A screw gear meshed with a larger cylindrical type gear.
            2.242 The shafts are at right angles.
            2.243 There is a tremendous speed reduction and consequently high increase in force.

Name ______________________ Date______________

Worksheet - Wedge and Screw

1. A wedge used for splitting logs is 8 in. long and one inch thick. If the efficiency is 40% how much force must be applied to exert a splitting force of 200 lb.?

2. What force can be exerted by a wedge 7 in. long and 1.5 in. thick if an effort force of 80 lb. is applied and the efficiency is 30%?

3. What effort applied at the end of an arm 24 in. long is needed to raise a 2000 lb. weight by means of a screw jack with a pitch of .25 in. if friction is neglected?

4. How much weight can be lifted by an effort of 5 lb. applied at the end of a jackscrew handle 18 in. long if the pitch of the screw thread is .50 in. and the unit is 60% efficient.

5. How long an effort arm is needed to lift one corner of a garage weighing 5 tons by means of a jackscrew with a .25 in. pitch if an effort of 50 lb. is exerted and the efficiency is 50%?

6. What is the pitch of a jackscrew which can lift a 2 ton weight with an effort of 7.97 lb. applied at the end of a rod 20 in. long? Efficiency is 30%.

3. Purposes of gears.

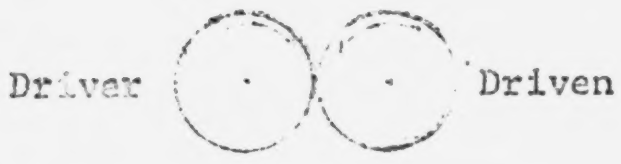
3.1 Transmit rotary motion.

3.11 Pulleys and belts can accomplish a similar purpose.

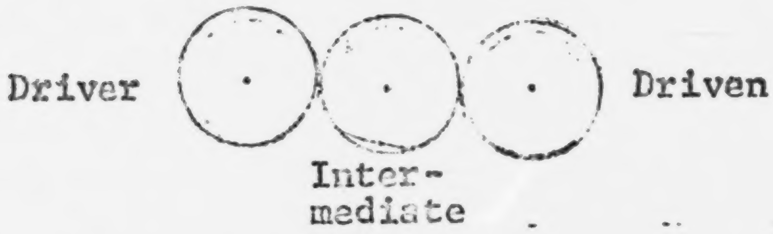
3.12 Gear is better because the teeth prevent slipping.

3.2 Change direction of rotary motion.

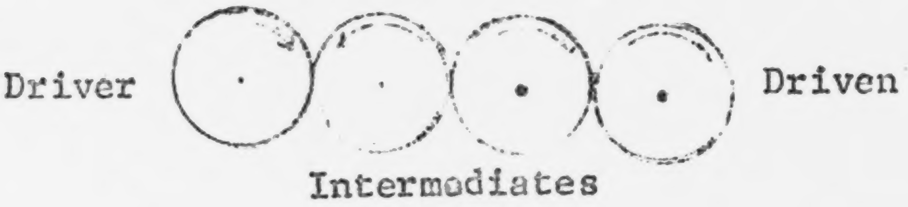
3.21 With two gears in mesh the driven gear rotates in the opposite direction to the driver.



3.22 An intermediate gear placed between the two will result in driven gear now moving in the same direction as the driver.



3.23 A second intermediate gear placed in the line will result in the driven again running opposite to the driver.



3.24 In general

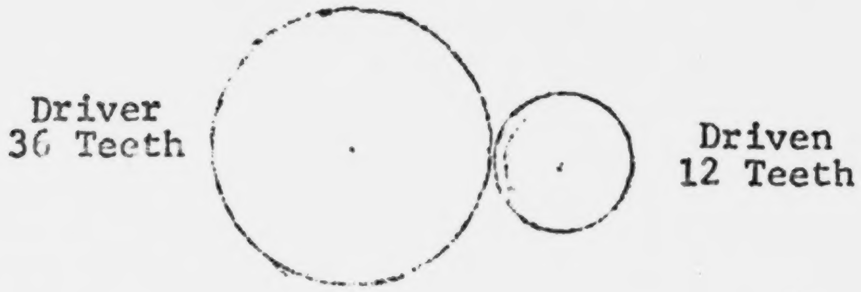
3.241 Odd number of intermediate gears--driver and driven rotate in same direction.

3.242 Even number of intermediate gears--driven rotates in the opposite direction to the driver.

3.3 Change speed

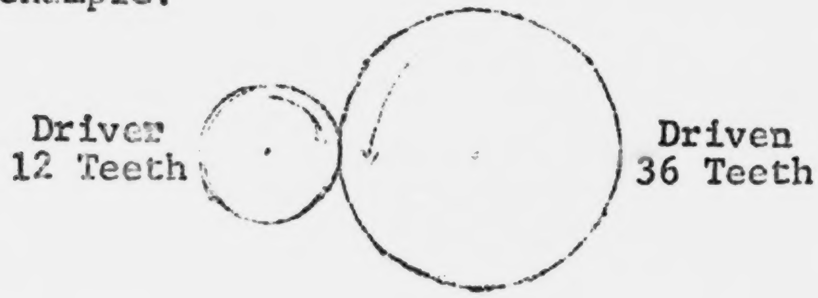
3.31 If the number of teeth in the two gears are not the same, the speed of the two gears will be different.

3.311 More teeth in driver than driven, the driven gear will move faster.
example:



In one turn there are 36 teeth to contact with the driven gear, and therefore 36 contacts with the driven gear must also be made. For this to happen, the driven gear must turn three times so it will rotate three times as fast.

3.312 More teeth in the driven than the driver gear.
example:



One turn of the driver causes a contact of 12 teeth with the driven. The driven gear will only turn one-third of a turn so the speed of the driver is reduced by a third.

3.32 Speed ratio of a gear set.

3.321 The speed of the driven gear is directly dependent upon the tooth ratio of the driver to driven gear.

3.322 Formula

$$V.R. = \frac{V_1}{V_2} = \frac{t_1}{t_2}$$

where VR is the speed ratio, V_1 is the speed of the driver, V_2 the speed of the driven, t_1 the number of teeth in the driver, t_2 the number of teeth in the driven.

3.323 Examples

3.3231 What is the speed ratio of a 58 tooth gear driving a 24 tooth gear?

$$V.R. = \frac{58}{24}$$

$$V.R. = 2.5$$

3.3232 What is the speed ratio of a 36 tooth gear driving a 90 tooth gear?

$$V.R. = \frac{36}{90}$$

$$V.R. = 0.4$$

3.324 For a gear train (more than two gears in mesh) the total speed ratio equals the product of the individual gear ratios.

Example: Four gears are in mesh, the driver has 36 teeth, the first intermediate has 18 teeth, the second intermediate has 24 teeth and the driven gear has 48 teeth. What is the speed ratio?

V.R. between driven and first intermediate $= \frac{36}{18}$

V.R. between first and second intermediate $= \frac{18=}{24}$

V.R. between second intermediate and driven $= \frac{24}{48}$

$$\text{Total V.R.} = \frac{36}{18} \times \frac{18}{24} \times \frac{24}{48}$$

$$V.R. = 0.75$$

3.325 The speed ratio of a gear set is also known as the mechanical advantage of speed.

3.4 Change Force

3.41 If the driven gear has more teeth than the driver the mechanical advantage of speed is less than one.

3.42 If this is true then the mechanical advantage of force must be greater than one.

3.43 Formula: $MA_F = \frac{t_2}{t_1}$

where MA_F is the mechanical advantage of force
t_2 is the number of teeth in the driven gear and
t_1 is the number of teeth in the driver.

3.44 Example: A driver gear has 18 teeth while the driven gear has 45 teeth, what is the MA_F?

$MA_F = \frac{45}{18}$ $\qquad$ $MA_F = 2.5$

4. Applications - Use wall charts of an automobile transmission and differential to identify types of gears and their purposes.

5. Assignment - Worksheet on gears and gear trains.

LESSON 17 - Compound Machines and Review of all Simple Machines

1. Review worksheet on gears.

2. Compound machines
   - 2.1 Most machines are a combination of one or more simple machines.
   - 2.2 The combination will result in an even higher mechanical advantage.
   - 2.3 Example: A winch in the front of a truck bed may be used to move a heavy load up a plank into the truck. The winch is a wheel and axle, while the plank is an inclined plane.

3. Mechanical advantage of a compound machine.
   - 3.1 The total mechanical advantage equals the product of the individual mechanical advantages of the simple machines which make up the compound machine.
   - 3.2 If the machine combination in 2.3 had an MA_F for the inclined plane of 3 and for the winch 8 then the total $MA_F = 3 \times 8$ or 24.

4. Pass out and discuss summary sheets for simple machines.

5. Assignment - Study summary sheet and complete worksheet on compound machines.

LESSON 18 - Friction

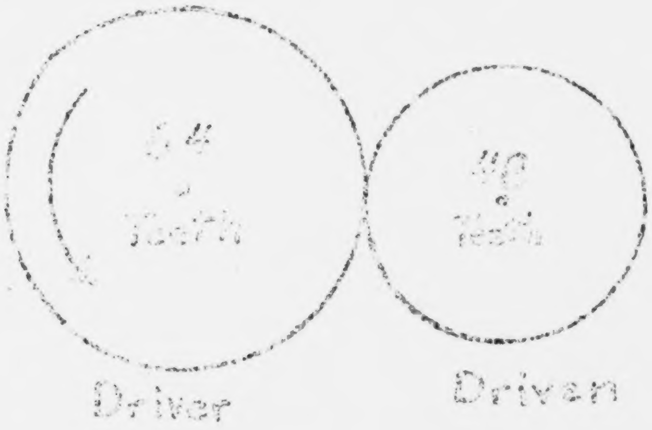
1. Review worksheet on compound machines.

Name________________________ Date______________

Worksheet - Gears and Gear Trains

On each gear diagram show the direction of rotation of each gear and determine the requested information.

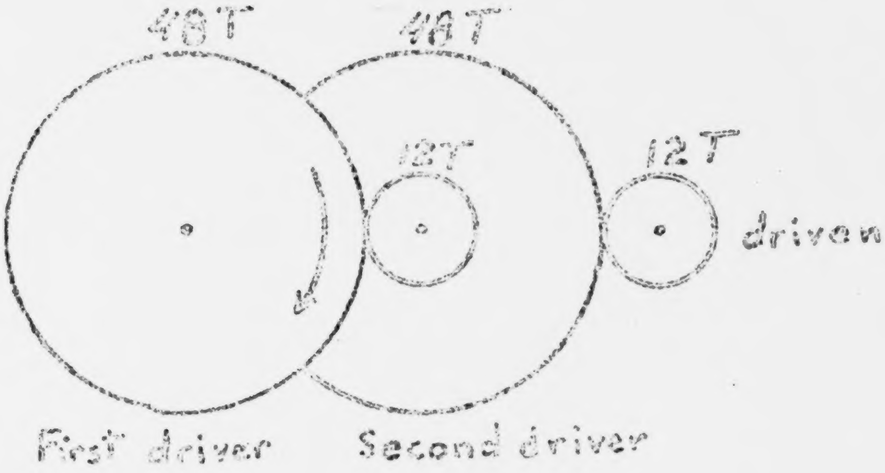
(1)


64 Teeth
40 Teeth
Driver
Driven

Speed ratio = ...

MA_F = ...

(2)


48T
48T
12T
12T
driven
First driver
Second driver

Speed ratio = ...

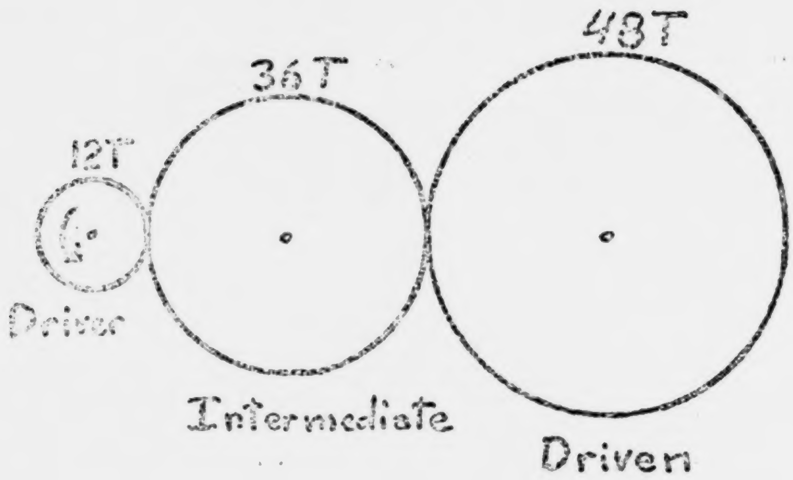
MA_F = ...

First driver turns at 64 rpm.

Second driver's speed = ...

Driven speed = ...

(3)


12T
36T
48T
Driver
Intermediate
Driven

Speed ratio = ...

MA_T = ...

Driver turns at 1800 rpm.

Intermediate turns at ....

Driven turns at ....

SUMMARY OF SIMPLE MACHINE RELATIONSHIPS

Machine	IMA	AMA	W_{IN}	W_{OUT}
General Relationships	$\frac{S_E}{S_R}$	$\frac{F_R}{F_E}$	$F_E \times S_E$	$F_R \times S_R$

S_E = effort distance S_R = resistance distance
F_E = effort force F_R = resistance force

Lever	$\frac{l_E}{l_R}$	$\frac{F_R}{F_E}$	$F_E \times S_E$	$F_R \times S_R$

l_E = length of effort arm l_R = length of resistance arm

Pulley	number of ropes supporting moveable block	$\frac{F_R}{F_E}$	$F_E \times S_E$	$F_R \times S_R$
Wheel and Axle	$\frac{r_L}{r_S}$	$\frac{F_R}{F_E}$	$F_E \times 2\pi r_L$	$F_R \times 2\pi r_S$

r_L = radius of large wheel or length of crank
r_S = radius of small wheel or axle

Inclined Plane	$\frac{l}{h}$	$\frac{W}{F_E}$	$F_E \times l$	$W \times h$

l = length of plane   h = height of plane   w = weight of object

Wedge	$\frac{b}{h}$	$\frac{F_R}{F_E}$	$F_E \times b$	$F_R \times h$

b = length of the base of the wedge
h = height or thickness of wedge

Screw	$\frac{S_E}{pitch}$	$\frac{F_R}{F_E}$	$F_E \times S_E$	$F_R \times$ pitch

pitch is the distance between the threads

Name________________________________ Date________________

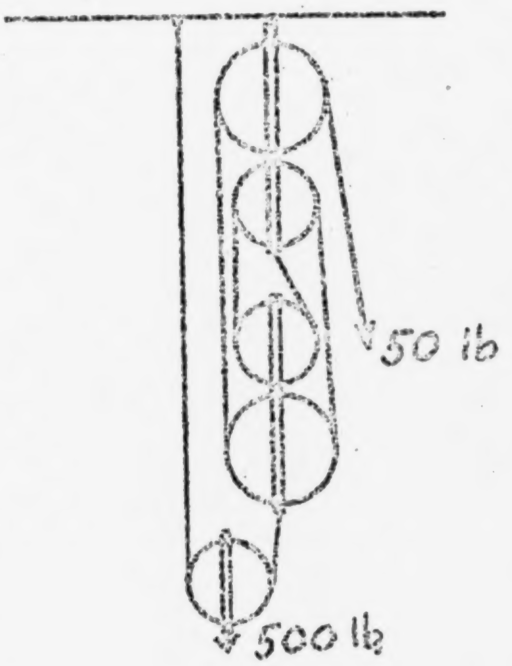
Worksheet - Compound Machines

1. A large safe weighing 2400 lb. is pulled up an incline 12 ft. long and three ft. high by means of a block and tackle. If an effort force of 100 lb. is used and friction is neglected what is the combined MA of the machine? What is the MA of the block and tackle? Make a sketch of the set up.

2. A 1200 lb. boat is loaded into a trailer by two feet high by means of a plank eight feet long and a winch whose drum is 3 in. in diameter and the handle is 16 in. long. If the system is 80% efficient how much effort force is required? Make a sketch of the system.

3. In each diagram determine the requested values.

(a)



S_E = 32 ft.

IMA = ...

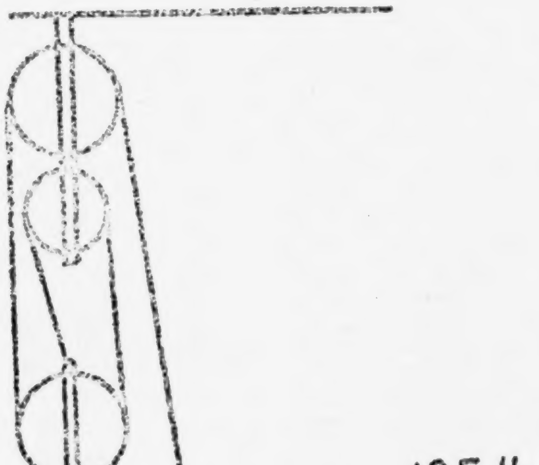
S_R = ...

W_{IN} = ...

W_{OUT} = ...

Eff. = ...

(b)



IMA = ...

S_R = ..6.ft....

S_E = ...

W_{IN} = ...

W_{OUT} = ...

Eff. = ...

2. Introduce concept of friction.
    - 2.1 Use the low friction air puck distributed by Edmund Scientific.
    - 2.2 Try sliding it across the table before inflating balloon (will not move very far)
    - 2.3 Inflate balloon and then try pushing it. (It will move very easily, not stopping until it runs into something or reaches the end of the table.)
    - 2.4 Other situations where little or no friction is experienced.
        - 2.41 Ice on sidewalks and roads.
        - 2.42 Holding a bar of wet soap.
        - 2.43 Highly waxed floors.

3. Definition of friction - The opposition to the movement of one object over another.

4. Causes of friction.
    - 4.1 Cause is not fully understood but there are several theories.
    - 4.2 Surface irregulautus.
        - 4.21 Uneven surfaces when rubbed together have a tendency to interlock, resulting in an opposition to the rubbing.
        - 4.22 Very highly polished surfaces experience an increase rather than decrease in friction.

    - 4.3 Other factors.
        - 4.31 Electrical forces
        - 4.32 Adhesion between the molecules of the two materials.

5. Importance of friction.
    - 5.1 Friction is beneficial.
        - 5.11 For movement
            - 5.111 Between tires on an automobile and the road.
            - 5.112 Between the foot and the sidewalk.

        - 5.12 For maintaining position.
            - 5.121 Screws and nails in wood.
            - 5.122 Knots in ropes and string.

        - 5.13 For stopping motion - brakes on an automobile.

    - 5.2 Friction is a hindrance.
        - 5.21 Moving parts in a machine.
        - 5.22 Wear on tires and shoe soles.

6. Types of friction.
    - 6.1 Starting friction - the friction force that has to be overcome to start the object moving is higher than that needed to keep it in motion.
    - 6.2 Sliding friction.
        - 6.21 The frictional force that has to be overcome to keep one object sliding over another.

6.22 Factors

6.221 The direction of the force is parallel to surfaces which are in contact and opposite in direction to that of the motion.

6.222 The amount of the force is dependent upon the force pushing the surfaces together. (Normal force)

6.223 The amount of force is dependent upon the types of materials and the nature of their surfaces.

6.224 Within the range of medium speeds there is little effect of speed upon the force of friction.

6.225 The area of contact has very little effect upon the force of friction.

6.3 Rolling friction.

6.31 It is easier to roll one object over another than to slide.

6.32 For steel the force of rolling friction may be as much as 0.001 of the sliding fricion between the two pieces of steel.

7. Coefficient of sliding friction.

7.1 The ratio of the force necessary to overcome sliding friction to the normal force for two particular surface which are in contact.

7.2 Represented by the Greek letter Mu (μ)

7.3 Equation:

$$\mu = \frac{f}{N}$$

where:
μ is the coefficent of sliding friction.
f is the force needed to overcome sliding friction
N is the force pushing the surfaces together.

7.4 Examples:

7.41 What is the coefficient of friction between a 75 lb. box and the floor if a force of 15 lb. is needed to slide it across the floor?

$$\mu = \frac{15 \text{ lb.}}{75 \text{ lb.}}$$

$$\mu = 0.20$$

7.42 How much force is needed to slide a 150 lb. box across the floor if the coefficient of sliding friction between the box and the floor is 0.30?

$$0.30 = \frac{f}{150 \text{ lb.}}$$

$$f = 150 \text{ lb.} \times 0.30$$

$$f = 45 \text{ lb.}$$

8. Reducing friction.
8.1 Using bearings
8.11 Polished bearings - The two surfaces in contact are machined and polished to smooth surface.
8.12 Ball and roller bearings.
8.121 Make use of the fact that rolling friction is less than sliding friction.
8.122 Roller bearings are desirable where the load is high as they offer a larger surface area than the ball bearings.

8.2 Anti-friction materials.
8.21 Some material combinations offer less friction than others.
8.22 A mixture of lead and antimony is used on connecting rod bearings as it has a low friction coefficient with steel.
8.23 Nylon and teflon bearings are used in many small machine parts.

8.3 Lubrication
8.31 Reduce friction by coating the surfaces with a thin film over which the parts slide easily.
8.32 Characteristics of a good lubricant
8.321 Must have sufficient body to stand up on the load and operating conditions of the machine.
8.322 Must flow freely enough to keep the parts coated with thin film.
8.323 Should be of such a chemical composition to prevent corrosion of the parts.

9. Assignment - Study notes and prepare for a test on machines.

Name__________________________ Date submitted_______________

Experiment 9 - BOYLE'S LAW

Purpose of experiment

To study the relationship between the pressure applied to a gas and the volume of the gas.

Apparatus

Boyle's law apparatus and a mercurial barometer.

Procedure

Pressure is applied to a gas sample by raising the open tube of the apparatus. The total pressure on the gas is found by adding the difference in mercury levels in the apparatus to the barometer reading.

Ten trials are made with different amounts of pressure.

A graph will be plotted using the volume values on the y-axis and the pressure values on the x-axis.

Data

Height of the closed arm______cm. Barometer reading_______cm.

Trial	Mercury level in closed arm (cm)	Volume of gas (cm)	Mercury level in open arm (cm)	Difference in mercury levels (cm)	Pressure on gas (cm)	Pressure-volume product
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Questions

1. What is the shape of the graph of the data from this experiment?

____

2. How do the pressure-volume products compare with each other?

____

3. From the answers to question #1 and #2, what relationship exists between the volume of a gas and the pressure exerted upon the gas?

____

____

4. As the pressure increases on a gas what happens to the density of the gas?______________________

Explain______________________________

____

____

Name______________________ Table__________ Date__________

Partner____________________ Instructor's Approval_____________

EXPERIMENT 9 - BOYLE'S LAW - ORIGINAL DATA SHEET

Height of closed arm_____cm. Barometer reading_____cm.

Trial	Mercury level in closed arm (cm)	Volume of gas (cm)	Mercury level in open arm (cm)	Difference in mercury levels (cm)	Pressure on gas (cm)	Pressure-volume product
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Name______________________________ Date submitted______________

Experiment 10 COMPOSITION OF FORCES

Purpose of experiment

1. To find the equilibrant of two forces acting at an angle to each other.
2. To compare the equilibrant with the resultant of the two forces.

Apparatus

3 weight hangers, 2 sets of slotted weights, string, 2 single pulleys, 2 instrument rods, cross arm for instrument rods, 2 clamps for cross arm, 2 collar hooks, protractor and ruler.

Procedure

Loops are tied in each end of the string and a large loop tied in the middle of the string. The string is threaded through the two pulleys which are hung from the collar hooks on the cross arm. 250 grams are hung on one end of the string and 400 grams on the other end. Weights are then added to the loop in the middle of the string until the string forms a right angle. The angle between this downward weight and each section of the string is carefully measured with the protractor.

A vector diagram is then drawn to scale of the three forces. The resultant of the two original forces is constructed, measured and then compared with the value and direction of the third force.

Data

Force A 250 g equals _____oz. ∠AOB equals 90°

Force B 400 g equals _____oz. ∠AOC equals____°

Force C _____g equals _____oz. ∠BOC equals____°

Resultant of forces A and B equals _______oz.

Angle between force A and resultant equals _______°

Questions

1. How does the value for the resultant compare with the experimental equilibrant force C?________________________________

____

2. Mathematically calculate the size and direction of the resultant. Show your method of doing this in a smooth form.

Name________________________ Table__________ Date__________

Partner________________________ Instructor's Approval__________

Experiment #10- COMPOSITION OF FORCES - ORIGINAL DATA SHEET

Force A 250g equals____oz. ∠ AOB equals 90°

Force B 400g equals____oz. ∠ AOC equals ____°

Force C ___g equals____oz. ∠ BOC equals ____°

Resultant of forces A and B equals_____oz.

Angle between force A and resultant equals _____°

VECTOR DIAGRAM OF THE FORCES

Name______________________________ Date submitted__________________

Experiment11 THE LEVER

Purpose of experiment

To study the three classes of levers.

Apparatus

Meter stick, 3 knife edge clamps, hangers for clamps, spring balance, weight hanger and slotted weights, 2 instrument rods, cross arm, 2 cross arm clamps, and a collar hook.

Procedure

Part 1 - First class lever

The meter stick is hung from its center of gravity. A resistance load of one kilogram is hung ten inches from the fulcrum. The third clamp is fastened 15 inches from the opposite side of the fulcrum and the spring balance is used to find the force necessay to left the load.

A second trial is made with the resistance at a greater distance from the fulcrum than the effort force.

Efficiency of the lever can by calculated from the ratio of the actual mechanical advantage to the ideal mechanical advantage multiplying this answer by 100%.

Part 2 - Second class lever

In this portion of the experiment the fulcrum is moved to the ten inch mark on the meter stick. The resistance of one kilogram is hung from the 20 inch mark and the effort is applied upward at the 30 inch mark.

For a second trial place the resistance at the 25 inch mark, keeping the effort and fulcrum positions the same.

Part 3 - Third class lever

The procedure is similar to that for the second class lever. The fulcrum remains in the same position. The effort is applied upward at the 20 inch mark and the resistance at the 25 inch mark.

For a second trial the effort is applied at the 25 inch mark and the resistance at the 30 inch mark.

Data

Class	Trial	F_E (oz.)	F_R (oz.)	l_E (in.)	l_R (in.)	IMA l_E/l_R	AMA F_R/F_E	Efficiency %
First	1							
	2							
Second	1							
	2							
Third	1							
	2							

Questions

1. Under what conditions will a first class lever have a mechanical advantage:

a. Greater than one?____

____

b. Less than one?____

____

2. Why is the mechanical advantage of the second class lever always greater than one?____________________________________

____

3. Why is the mechanical advantage of the third class lever always less than one?_______________________________________

____

4. For each of the following lever classifications give two tools in your shop which are applications of this lever type.

a. First class M.A. greater than one.____________________________

____

b. First class with M. A. less than one.____________________

____

c. Second class________________________________

d. Third class_________________________________

Name________________________ Table__________ Date__________

Partner________________________ Instructor's Approval______________

EXPERIMENT #11 - THE LEVER - ORIGINAL DATA SHEET

Class	Trial	F_E (oz.)	F_R (oz.)	l_E (in.)	l_R (in.)	IMA l_E/l_R	AMA F_R/F_E	Efficiency %
First	1							
	2							
Second	1							
	2							
Third	1							
	2							

Name______________________________ Date submitted_________________

Experiment 12 - THE PULLEY

Purpose of experiment

To study the mechanical advantage and efficiency of pulley systems.

Apparatus

2 single pulleys, 2 double pulleys, 2 triple pulleys, string, 2 weight hangers and slotted weights, meter stick, 2 instrument rods, cross arm, 2 cross arm clamps and 2 collar hooks.

Procedure

Pulley systems with ideal mechanical advantages from one to six are to be set up. For each system a resistance load of one kilogram will be used. The effort needed to raise the load will be measured by applying weights to weight hanger until the resistance moves upward at a uniform rate. The meter stick is used to measure the effort and resistance distances.

Efficiency is calculated from the ratio of the work output to the work input and miltiplying this result by 100%.

Data

Ideal	F_R (oz.)	F_E (oz.)	S_R (in.)	S_E (in.)	Work output $F_R x S_R$	Work input $F_E x S_E$	Efficiency %
1							
2							
3							
4							
5							
6							

Questions

1. What is a quick easy way of determing the ideal mechanical advantage of a pulley system?_________________________

____

2. What should happen to the afficiency of a pulley system as the mechanical advantage is increased?______________________

____

Explain____

____

____

3. What are two practical applications of a single fixed pulley?

a.____

b.____

4. What are three possible used of a pulley system in your shop area?

a.____

b.____

c.____

5. A 300 pound motor block has to be lifted out of an automobile. The maximum amount of force that can be exerted is 100 pounds. What should be the ideal mechanical advantage of a pulley system which could be used to lift this motor without exceeding the 100 lb.?__________________.

In the space below sketch a diagram of the pulley system for this problem.

Name________________________ Table______________ Date______________

Partner______________________ Instructor's approval________________

Experiment #12 - THE PULLEY - ORIGINAL DATA SHEET

Ideal M.A.	F_R (oz.)	F_E (oz.)	S_R (in.)	S_E (in.)	Work output $F_R \times S_R$ (oz.-in.)	Work input $F_E \times S_E$ (oz.-in.)	Efficiency %
1							
2							
3							
4							
5							
6							

Name______________________________ Date submitted________________

Experiment 13 - THE INCLINED PLANE

Purpose of experiment

To study the mechanical advantage and efficiency of the inclined plane.

Apparatus

Inclined plane, instrument rod, right angle clamp, 12 inch flexaframe rod, Hall's carriage, weight hanger, set of weights, string, meter stick, and a triple beam balance.

Procedure

The higher end of the plane is supported by the flexaframe rod which is clamped with the right angle clamp to the instrument rod. The weight of the car is found with the balance. The string attached to the car is placed on the pulley on the inclined plane and the weight hanger attached to the end of the string. The effort force is found by the amount of weight needed to pull the car up the plane at a slow uniform speed.

Three trials are to be made, the first with the empty car, the second with a 500 gram load in the car and the third with the same load as the second but with the plane set at a different height.

Data

Trial	1	2	3
Length of plane (in.)			
Height of plane (in.)			
I.M.A.			
Effort force (oz.)			
Resistance force (oz.)			
A.M.A.			
Work output (oz.-in.)			
Work input (oz.-in.)			
Efficiency (%)			

Questions

1. What effect does increasing the height of the plane have on the mechanical advantage?______________________________

____

____

2. If the car was part of the machine instead of part of the resistance, what effect would this have on the efficiency of the machine?____

Explain____

____

____

3. What are two applications of the inclined plane commonly found around the home?

a.____

b.____

4. What are two applications of the inclined plane in your shop area?

a.____

b.____

Name________________________________ Table______________Date_______________

Partner_____________________________ Instructor's Approval_______________

Experiment #13 - THE INCLINED PLANE - ORIGINAL DATA SHEET

Trial	1	2	3
Length of plane (in.)			
Height of plane (in.)			
I.M.A.			
Effort force (oz.)			
Resistance force (oz.)			
A.M.A.			
Work output (oz.-in.)			
Work input (oz.-in.)			
Efficiency (%)			

Name ______________________ Date submitted ______________

Experiment 14 - SLIDING FRICTION

Purpose of experiment

To study the effects of normal force and surface area upon the force of sliding friction.

Apparatus

Wood block 3" X 2" X ½", inclind plane board for friction surface, spring balance, set of weights and meter stick.

Procedure

The weight of the block is measured with the spring balance and the area determined for each surface with the meter stick. The block is then placed with the largest surface down on one end of the friction surface. The block is then pulled at a slow uniform speed across the surface with the spring balance. The force required to move the block at this rate is recorded as the force of friction. Three additional trials are made with weight added to the block to change the normal force.

Two more sets of trials are to be made using the same normal forces but different surface areas of the block.

The coefficient of friction for each trial will be calculated by dividing the force of friction by the normal force.

Data

Surface area (in.^{2})	Trial	Normal force (oz.)	Force of friction (oz.)	Coefficient of Friction
	1			
	2			
	3			
	4			
	1			
	2			
	3			
	4			
	1			
	2			
	3			
	4			

SLIDING FRICTION - Page 2

1. How do the values for the coefficient of friction for the various trials compare with one another?

____

____

2. What effect does the normal force have on the force of sliding friction?

____

____

3. What effect does the surface area have on the force of sliding friction?

____

____

4. Give two examples where friction is helpful in your shop course.

a.______________________________________

b.______________________________________

5. Give two examples where friction is not desirable in your shop course.

a.______________________________________

b.______________________________________

6. How do you attempt to overcome the friction in the examples given in #5?

a.______________________________________

b.______________________________________

Name______________________________ Table________ Date__________

Partner____________________________ Instructor's approval__________

Experiment ## - SLIDING FRICTION - ORIGINAL DATA SHEET

Surface Area (in.^{2})	Trial	Normal force (oz.)	Force of friction (oz.)	Coefficient of friction
	1			
	2			
	3			
	4			
	1			
	2			
	3			
	4			
	1			
	2			
	3			
	4			

3^{rd} UNIT

LESSON 1 - Introduction to Static Electricity

1. Discuss and list situations where the students have encountered static electric charges.
1.1 Walking across a rug and touching a light switch.
1.2 Combing hair.
1.3 Sliding across a car seat.
1.4 Rubbing an inflated balloon on a sweater than having it stick to the wall.

2. Static electricity is an old, well known phenomena.
2.1 Thales
2.11 A wise man of ancient Greece.
2.12 Observed about 600 B.C. that amber, when rubbed with wool would attract small bits of wood shavings.

2.2 William Gilbert (1540 - 1603)
2.21 Discovered that materials other than amber would produce similar affects.
2.22 Credited with naming the phenomena electricity from the Greek work for amber, elektron.

3. Types of electric charge.
3.1 Rub a hard rubber rod with fur and bring it near a suspended pith ball, note the attraction (don't allow contact)
3.2 Repeat with a glass rod rubbed with silk, note the similarity of behavior.
3.3 Repeat 3.1 allowing the pith ball to touch the rod--the ball will then be repelled and will be repelled by any charged rubber rod.
3.4 Bring the glass rod near the pith ball and note that it is again attracted until contact is made and then repelled.
3.5 Evolve from the demonstration that there seem to be two different kinds of electric charge.
3.51 Hard rubber when rubbed with fur becomes negatively charged.
3.52 Glass when rubbed with silk becomes positively charged.

3.6 First law of electrostatics - objects with similar electrical charges repel each other while objects with unlike charges attract each other.

4. Electrification and the structure of matter.
4.1 Briefly review the basic concepts of the structure of the atom.
4.2 What is an atom?
4.21 Smallest particle into which a chemical element can be divided.
4.22 Over 100 different types of atoms.

4.3 Structure of the atom.
4.31 Nucleus
4.311 Dense central portion of atom.
4.312 Contains most of the atom's mass.
4.313 Particles
4.3131 Protons - positively charged particles.
4.3132 Neutrons - neutrally charged particles.

4.32 Electron cloud.
4.321 Occupy space around nucleus.
4.322 Contains the electrons - negatively charged particles.
4.323 In a neutral atom the number of electrons is the same as the number of protons.

4.4 Electrification is dependent upon the electron-proton ratio.
4.41 Positively charged - fewer electrons than protons.
4.42 Negatively charged - more electrons than protons.
4.43 Since protons are held within the nucleus of the atom electrification is brought about by the movement of electrons.

5. Production of static electricity.
5.1 Static electricity - electricity at rest.
5.2 Most static charge is developed by friction.
5.21 The heat produced by the friction is sufficient to enable some electrons to leave the atoms.
5.22 Some objects have a greater attraction for these free electrons and they become the negatively charged bodies.
5.23 The ones with a less attraction become positively charged.
5.231 With the fur and rubber - fur becomes positive, rubber negative.
5.232 With the silk and glass - silk becomes negative, glass becomes positive.

6. Assignment - Study notes and write up definitions of new terms.

LESSON 2 - Static Electricity

1. Quiz on material covered in Lesson 1.

2. Transfer of electric charges.
2.1 By contact.
2.11 Some of excess charge moves to the neutral body until charge concentration is the same on both bodies.

Name ______________________________ Date ______________

Quiz for Lesson 1

In the answer spaces write whether the following statements are true or false.

1. Static electricity was first observed by William Gilbert. 1. ....

2. When a rubber rod is rubbed with fur the fur becomes negatively charged. 2. ....

3. Protons and neutrons are found in the nucleus of an atom. 3. ....

4. A glass rod develops a positive charge when rubbed with silk. 4. ....

5. Objects with the same electric charge repel each other. 5. ....

6. Objects with a negative charge have a deficiency of electrons. 6. ....

7. Static electricity is generated by friction. 7. ....

8. Protons carry a negative electrical charge. 8. ....

9. Objects with unlike charges repel each other. 9. ....

10. Electrons carry a negative electrical charge. 10. ....

2.12 The charged body will have the same sign as the charging body.

2.2 By induction.
- 2.21 Charging body does not touch the object to be charged.
- 2.22 If the charging body is negative it causes some electrons to be repelled in the neutral body to the portion of the body farthest from the charging body.
- 2.23 If the electrons are allowed to run off (by grounding) the object will then have a positive charge.
- 2.24 With a positive charging body the electrons will be attracted and grounding will allow additional electrons to flow into the object.
- 2.25 An object chaged by induction has a charge opposite in sign to the charging body.

3. Discharging a charged body.
- 3.1 By grounding (contact).
  - 3.11 Object is connected to the earth.
  - 3.12 Earth acts as an unlimited source or receiver of electrons.
  - 3.13 If object is negatively charged excess electrons will move into the ground.
  - 3.14 If object is positively charged electrons will be drawn from the ground.
- 3.2 By electric arc.
  - 3.21 If charge concentration is high enough it will cause the surrounding air to be ionized.
  - 3.22 Ionized air is a good carrier of charge so the charge will jump in the form of a spark or arc.
  - 3.23 Charge concentration must be very high for this to occur.

4. Movement of charge.
- 4.1 Electric current.
  - 4.11 In solids the electrons are the movable charges.
  - 4.12 Charge will move between two points if there is an unbalance of charge between these points.
  - 4.13 Direction of the motion since electrons are the carriers will be from negative to positive.
  - 4.14 The movement of charge is called an electric current.
- 4.2 Conductors and insulators.
  - 4.21 Support a metal rod and a glass rod on insulated stands with one end of each near a suspended pith ball.
  - 4.22 Touch the opposite end of each rod with a charged rubber rod.
  - 4.23 The pith ball will be attracted to the metal rod.
  - 4.24 Evolve the concept that some materials will carry charge while others will not.

4.241 Conductor - a material which will readily conduct electric charge.
4.242 Insulator - a material which will not easily conduct electric charge.

5. Detection of electric charge.
5.1 Pith ball electroscope.
5.11 A charged object brought near the suspended pith ball causes the ball to be attracted to the object but upon contact the ball is repelled.
5.12 If a neutral object is brought near the ball now, the ball will be attracted again but not repelled.
5.13 Test for charge is repulsion, not attraction.

5.2 Leaf electroscope.
5.21 Construction
5.211 Two small pieces of metal foil attached together at one edge and fastened to a metal rod which has a metal sphere on top.
5.212 The leaf end of the rod is held in an enclosure (jar or flask) by means of a rubber stopper.

5.22 A charged object brought near the ball on top will cause the leaves to spread apart.
5.23 The amount the leaves spread will depend on the amount of charge on the object.
5.24 Uses of the electroscope
5.241 Detect the presence of a charge.
5.242 Determine sign of the charge.
5.243 Measure amount of charge.
5.244 May measure quantities of radioactivity.

6. Assignment - Study notes and write up definitions of any new terms in notebook.

LESSON 3 - Static Electricity

1. The capacitor.
1.1 Charge a Leydon jar and then discharges it.
1.2 Recharge the jar and take the top off.
1.21 Offer the separate parts to different students.
1.22 Reassemble the jar and discharge it.

1.3 Explain action of a capacitor.
1.31 Use a demonstration capacitor and leaf electroscope.
1.32 Amount of charge stored on one plate can be increased by the near by the presence of a second plate.

1.33 Grounding second plate further increases amount that can be stored (leaves diverge farther on electroscope).
1.34 Insulating material placed between the two plates also affects amount that can be stored.

1.4 What is a capacitor?
1.41 Two conducting plates separated by an insulator.
1.42 Can be used to store electric charger.

1.5 Factors affecting the amount of charge stored.
1.51 Size of plates.
1.52 Distance between the plates.
1.53 Type of insulating material (dielectric).

1.6 Types of capacitor. (display and explain each type)
1.61 Leydon jar.
1.62 Fixed capacitors
1.621 Tubular foil and paper types.
1.622 Electrolytee types.

1.63 Variable capacitors

2. Static electric generators.
2.1 Electrophorous
2.11 A non conducting base of hard rubber or wax.
2.12 A metal plate equipped with an insulating handle.
2.13 Base is charged by rubbing with fur.
2.14 Plate is set on top of base and grounded.
2.15 Plate now has a residual charge developed by induction.
2.16 If plate is lifted by the handle and the free hand brought near the plate a spark will jump between the plate and the hand.

2.2 Wimshurst machine
2.21 Basically a continuously operating electrophorous.
2.22 Charges developed by the machine are collected in attached Leydon jars until enough has built up to produce a good sized spurt.

2.3 Van de Graaf generator
2.31 A large sphere supported on an insulating column attached to a metal base.
2.32 A rubber belt runs up over a pulley in the sphere, through the column to a motor driven pulley in the base.
2.33 Static charges built up by the belt moving over the pulleys are collected on the large sphere.
2.34 High charge concentrations are developed on the sphere and very large sparks will occur.

3. Hazards of static charges.
    3.1 Automobiles traveling over the road develop a charge which is grounded by wires placed in the road near toll booths.
    3.2 Trucks carrying flammable fluids are continually grounded by a chain or strap to prevent charge build up.
    3.3 Belts on machinery need to be grounded or they will build up a large concentration of charge.

4. Assignment - Study for test on Static Electricity.

LESSON 4 - Magnitism

1. Introduction
    1.1 Display a variety of magnets letting the students examine the shapes, strength, etc. of the various magnets.
    1.2 Where have they encountered magnets?
        1.21 Toys
        1.22 Electrical appliances
        1.23 Door catches on cabinets and refrigerators.

2. What is magnetism?
    2.1 An attractive and repulsive force which affects certain materials.
    2.2 A field type force which does not require actual contact to be exerted.
    2.3 Is very closely associated with many electrical phenomena.

3. What materials are magnetic?
    3.1 Natural magnets.
        3.11 Called lodestones.
        3.12 A form of iron ore (magnetite)
        3.12 Found in a part of Turkey (Magnesia) and also upper part of New York State.

    3.2 Chemical elements - iron, nickel and cobatt.
    3.3 Some metal alloys - Alnico, steel and ceramic materials.

4. Magnetic poles.
    4.1 Show that the magnetic force in most magnets is concentrated in certain regions.
    4.2 The regions on a magnet where the force is concentrated are called poles.
    4.3 Suspend a magnet so that it can rotate in a horizontal plane.
        4.31 The magnet comes to rest in a North - South direction.
        4.32 One pole will always point to the North and is referred to as the North Pole.
        4.33 The other pole is thus called the South Pole.

5. Interaction of poles.
   - 5.1 Using two large magnetron magnets have two boys try to push them together when their same poles are facing each other.
   - 5.2 Have the same two attempt to maintain a very small amount of space between the poles when opposite poles are facing each other.
   - 5.3 From this evolve the concept that like magnetic poles upset and unlike poles repel.

6. The magnetic field.
   - 6.1 On an overhead projector place a bar magnet with a sheet of glass over it and use this with iron filings to get the picture of a magnetic field.
   - 6.2 Filings seem to form into lines concentrated at the poles.
   - 6.3 Magnetic lines of force.
     - 6.31 Similar in purpose to grid lines on a map or graph.
     - 6.32 Used to help predict what happens in a magnetic field.
     - 6.33 Characteristics of these lines.
       - 6.331 Act like stretched elastic bands.
       - 6.332 Have a direction - leave the magnet at the N pole and enter at the S pole.
       - 6.333 Are closed loops.
       - 6.334 Never intersect or cross other lines.
       - 6.335 Exert a sidewise force on each other.

7. Assignment - Worksheet on magnetic fields.

LESSON 5 - Magnetism

1. Spot check worksheet on magnetic fields.

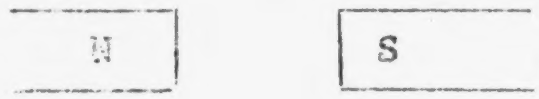
2. Permeability
   - 2.1 Introduce with a rod of permalloy and a demonstration compass needle.
     - 2.11 Holding rod in an E - W direction show that either end of the compass needle is attracted to all parts of the rod.
       i.e. rod is made of magnetic material but is not a magnet.
     - 2.12 Hold rod in a N - S direction and check again with compass. The rod is now a magnet.
     - 2.13 Reversing direction of rod reverses its polarity.
     - 2.14 The rod is made of an extremely permeable material with a low retentivity.
   - 2.2 Definition of permeability - The ability of a material to concentrate magnetic lines of force.

Name________________________________ Date____

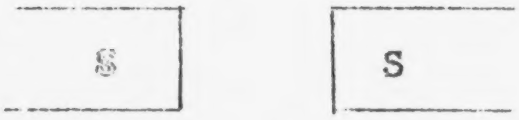
Worksheet on Magnetic Fields

On each diagram draw the magnetic field and predict what may happen.

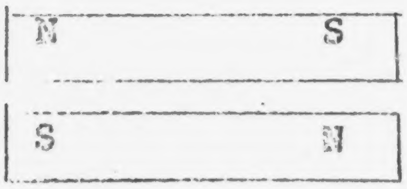
1.



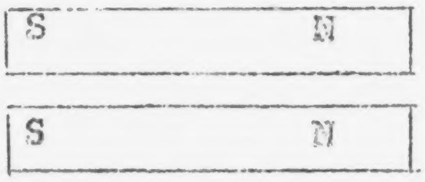
2.



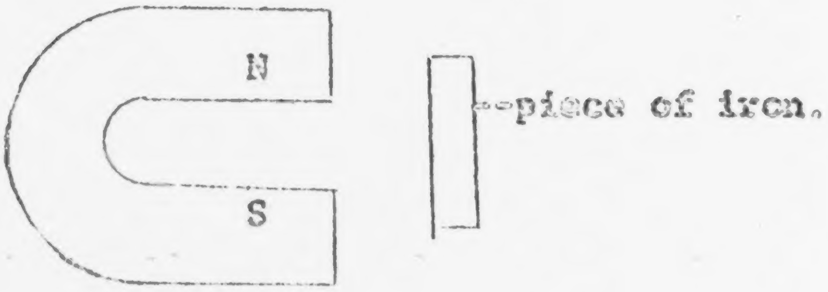
3.



4.



5.


N
S
--piece of iron.

3. Magnetic shielding.
   - 3.1 Test the transparency of materials to magnetic fields by placing a strong magnet above the material and try to pick up small magnetic objects.
   - 3.2 Nonmagnetic materials are transparent to magnetic forces.
   - 3.3 Magnetic materials are opaque to magnetic forces.
     - 3.31 The lines of force are concentrated within the material.
     - 3.32 A steel watch case will carry the lines of force around the mechanism and thus prevent the mechanism from becoming magnetized.

4. Magnetizing an object.
   - 4.1 By induction
     - 4.11 Object is placed in a magnetic field but not in contact with the magnet.
     - 4.12 Object will concentrate the lines of force and exhibit the properties of a magnet.

   - 4.2 By contact
     - 4.21 Stroking the object in one direction with one pole of the magnet.
     - 4.22 Object will then display magnetic properties.

5. Residual magnetism
   - 5.1 Magnetic properties remaining after the magnitizing force is removed.
   - 5.2 Temporary magnets - very little residual magnetism.
   - 5.3 Permanent magnets - high degree of residual magnetism.

6. Assignment - Study notes and write up definitions of new terms in notebook.

LESSON 6 - Electromagnetism

1. Magnetic field around a current carrying conductor.
   - 1.1 Demonstrate the phenomena with a compass and a wire connected to a dry all.
   - 1.2 Field about the conductor was first observed by Hand Christian Oerstect in 1819.
   - 1.3 Strength of the field depends upon:
     - 1.31 Amount of current
     - 1.32 Distance from the conductor.

   - 1.4 Direction of the field.
     - 1.41 Depends upon the direction of current.
     - 1.42 Left Hand Rule - grasp the conductor with the left hand so that the thumb points in the direction of the current. The fingers will circle the conducter in the same direction as the magnetic field

2. Field about a single loop or helix.
   2.1 Apply the left hand rule to a single loop of wire.
   2.2 On one face of the loop the lines of force will be coming out of the loop i.e. a N. pole.
   2.3 On the other face of the loop the lines will be going into the loop i.e. a S. pole.
   2.4 Reversing the current will result in a reversal of the polarity.

3. The solenoid and electromagnet
   3.1 A solenoid is a coil of many turns of wire.
      3.11 The magnetic field about adjacent turns of wire are in the same direction so they will add to one another.
      3.12 The solenoid will behave like a weak magnet when carrying current.
      3.13 Direction of field, Left Hand Rule for Coils--grasp the coil with the left hand so that the fingers circle the coil in the direction of the current. The thumb will then point in the direction of the N. pole.

   3.2 The electromagnet.
      3.21 Insert a permeable core into a current carrying coil and observe the effects.
         3.211 If only the end of the core is inserted the rest will be drawn in rapidly by the magnetic field.
         3.212 The coil will now be much stronger as the core concentrates the magnetic field.

      3.22 Strength of the electromagnet.
         3.221 Increasing the current increases the strength.
         3.222 The more turns of wire the stronger the magnet.
         3.223 Referred to as "ampere turns".

4. Applications of electromagnets - discuss construction and operation of the following:
   4.1 Door bell
   4.2 Door chime
   4.3 Relay switches
      4.31 Circuit breakers
      4.32 For circuit controls

5. Assignment - Study for test on magnetism.

LESSON 7 - Direct Current Electricity

1. Electrical current
1.1 Movement of electric charge.
1.2 Quantity of charge.
1.21 Smallest known quantity of charge is that carried by an electron.
1.22 Coulomb
1.221 Basic unit of electric charge.
1.222 Equal to the amount of charge on 6.3 x 10^{18} electrons.

1.3 Measuring current
1.31 Since current involves the flow of charge two factors must be considered.
1.311 Quantity of charge
1.312 Time involved

1.32 Current is generally referred to as the rate of flow of charge.
1.33 Ampere
1.331 Unit of measure for current.
1.332 Equals a flow rate of 1 coulomb per second.

1.34 The ammeter
1.341 The instrument used to measure current.
1.342 Three general types
1.3421 Standard ammeter - measures current in amperes.
1.3422 Milliammeter - measures currents from one milliampere to one ampere.
1.3423 Microammeter - measures very small currents from one microampere up to one milliampere.

1.342 Since the ammeter is measuring the current through a circuit it must be connected into the circuit so that the current has to flow through the meter as well as the rest of the circuit.

2. Electromotive force
2.1 Electric charge will not move unless there is something to move it. (Lesson 2, part 4.12)
2.2 In order to develop this unbalance of charge work has to be done on the charge.
2.3 The charge will then have the potential of doing the same amount of work as the charge moves back to the balanced condition.
2.4 The measure of this work potential is called the electromotive force or potential difference.

- 2.5 The volt
  - 2.51 Unit for measuring amount of electromotive force.
  - 2.52 Equals a work potential of one joule per coulomb of charge.
  - 2.53 Illustration:
    - 2.531 An ordianary "D" size flashlight cell has a potential of 1.5 volts.
    - 2.532 Connect the cell to a small light bulb.
    - 2.533 The bulb will give off heat and light which is due to the work which is being done by the charge as it moves through the lamp. (1.5 joules for every coulomb of charge)
    - 2.534 Connect two cells in series.
    - 2.535 The potential will now be 3.0 volts.
    - 2.536 When connected to the bulb the light will be brighter since each coulomb of charge is now able to do 3 joules of work.
- 2.6 Measuring potential difference (Voltage)
  - 2.61 Instrument used is called a voltmeter.
  - 2.62 Like ammeters, voltmeters are graduated for the ranges to be measured.
    - 2.621 Kilovoltmer for voltages above one thousand
    - 2.622 Voltmeter for voltages from one to a thousand
    - 2.623 Millivoltmenter for voltages for 0.001 to one.

3. Assignment - Study terms and write definitions in notebooks.

LESSON 8 - Direct Current Ohm's Law and Resistivity

Note: This lesson should follow the experient on Ohm's Law.

1. Ohm's Law experiment.
   - 1.1 Results
     - 1.11 For each conductor tested the voltage to current ratios are constant.
     - 1.12 The graph of voltage as a function of current for each conductor is a straight line.
   - 1.2 Conclusion - Ohm's Law
     - 1.21 In a given conductor, temperature remaining constant, the ratio of voltage to current is a constant called resistance

1.22 Equation:

$\frac{V}{I} = R$ Where: V is the voltage across the conductor, I is the current through the conductor and R is the resistance.

1.23 Units - if V is in volts and I in amperes then R will be in ohms.

1.3 Examples:

1.31 If a potential of 15 volts will maintain a current of 0.5 amp., what is the resistance of the conductor?

$R = \frac{15\ V}{0.5a}$ $R = 30.\ \text{ohms}.$

1.32 How much potential will be needed to provide a current of 5 amp. through a 35 ohm resistance?

$$35\ \text{ohm} = \frac{V}{5\ \text{amp.}}$$

$$V = 5\ \text{amp.} \times 35\ \text{ohm}$$

$$V = 175\ \text{volts}$$

1.33 What current will a 120 volt potential maintain in a 100 ohm resistance?

$$\frac{120V}{I} = 100\ \text{ohm}$$

$$I = \frac{120\ V}{100\ \text{ohm}}$$

$$I = 1.2\ a.$$

2. Factors affecting resistance.
   2.1 Important concept - voltage and current have no control over the value of the resistance.
   2.2 Length of conductor - directly affects resistance.
   2.3 Cross sectional area of conductor - inversely affects resistance.
   2.4 Type of material - some offer more resistance than others.
   2.5 Temperature - for most conductors, the higher the temperature the higher the resistance.
   2.6 Resistivity
      2.61 Frequently called specific resistance.
      2.62 Is the resistance of a material of unit length and unit cross sectional area.
      2.63 Equation:

$p = \frac{RA}{l}$ or more commonly

$$R = p\frac{l}{A}$$

where: R is the resistance, p is the resistivity, l is the length and A is the cross sectional area.

2.64 The circular mil.
  - 2.641 A convenient unit of cross sectional area measure for wire in the English system.
  - 2.642 Equals the area of a circle one mil in diameter.
    - 2.6421 A mil is one thousandth of an inch.
    - 2.6422 Examples:

Diameter (mils)	Area (circ. mils)
1	1
2	4
6	36

2.65 Resistivvity units
  - 2.651 Metric system - ohm--cm.
  - 2.652 English system - ohm-circ. mil/ft.

2.66 Examples:
  - 2.661 What is the resistance of 100 ft. of wire with a diameter of 0.01 in. if its resistivity is 20 ohm-circ.mil/ft.?

0.01 in. = 10 mils and A = 100 circ. mils

$$R = 20 \text{ ohm-circ. mil/ft.} \times \frac{100 \text{ ft.}}{100 \text{ circ. mil}}$$

$$R = 20 \text{ ohms.}$$

  - 2.662 What is the resistivity of 250 cm of wire if its resistance is 75 ohms and its cross sectional area is 2.5 cm.2?

$$75 \text{ ohms} = P \frac{250 \text{ cm}}{2.5 \text{ cm}^2}$$

$$P = \frac{2.5 \text{ cm}^2 \times 75 \text{ ohms}}{250 \text{ cm}}$$

$$P = 0.75 \text{ ohm-cm}$$

3. Assignment - Worksheet on Ohm's Law and resistivity.

LESSON 9 - Series Circuits

1. Check over worksheet on Ohm's Law and resistivity.

2. Series circuit
   - 2.1 A series circuit is a method of connecting electrical components so that the current has to flow through each component in succession.
   - 2.2 Set up a demonstration series circuit with three resistances of different values, four ammeters, four voltmeters and a variable direct current source.

Name______________________________ Date_____

Worksheet on Ohm's Law and Resistivity

1. To maintain a current of 3 amperes through certain appliances the following potentials were needed. What is the resistance of each appliance?

   a) 120V.
   b) 75V.
   c) 270V.
   d) 96V.
   e) 1.5V.
   f) 18.6 V.

2. A potential of 120 volts was applied to a number of conductors. What is the resistance of each of these conductors if they carried the following currents?

   a) 1.2a.
   b) 24 ma.
   c) 3a.
   d) 0.6a.
   e) 150 ma.
   f) 7.5 ma.

3. What voltage must be applied to a 75 ohm resistance in order to obtain the following currents?

   a) 2 a.
   b) 15 ma.
   c) 120 ma.
   d) 0.65 a.
   e) 4.5 ma.
   f) 0.85 a.

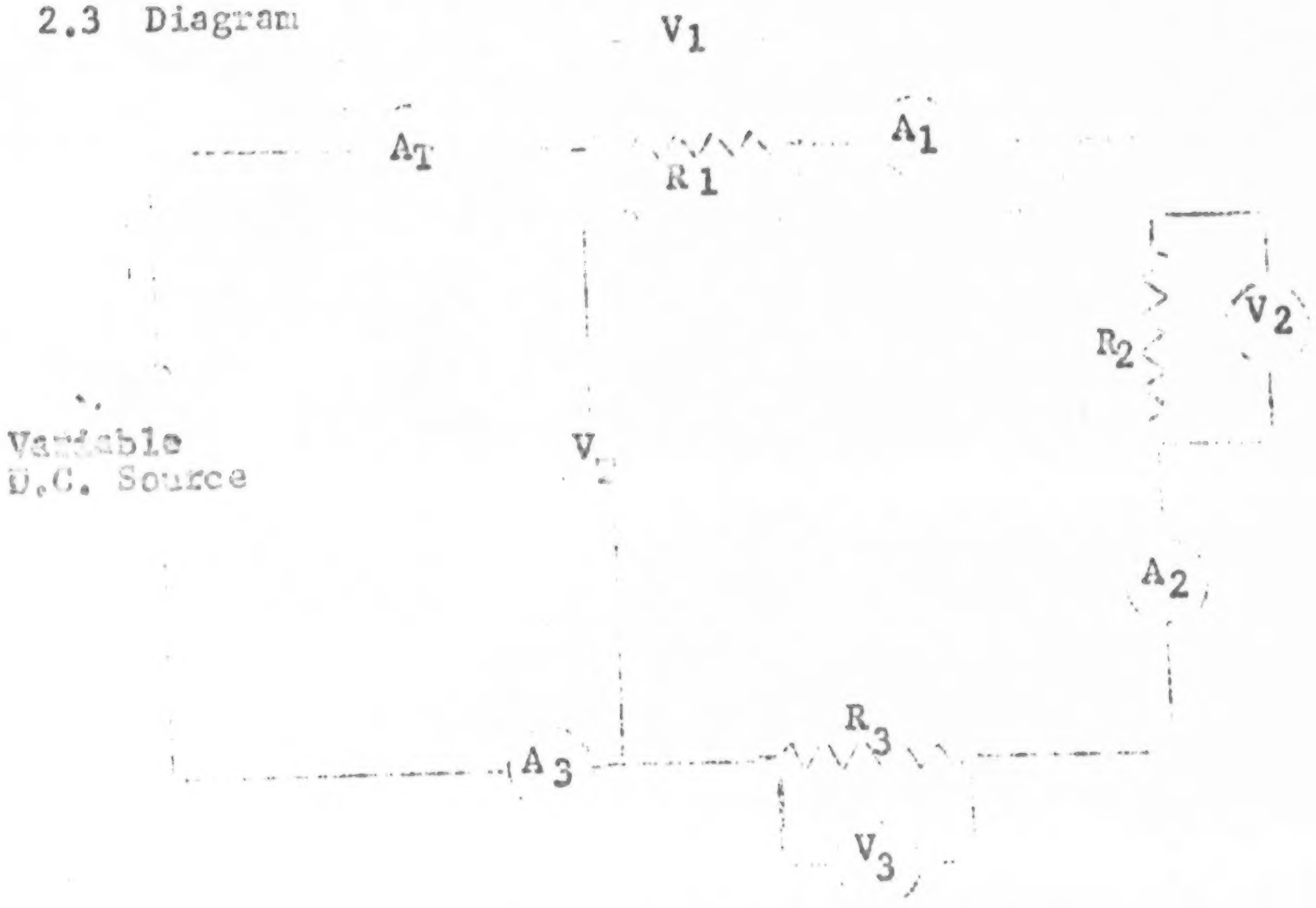
4. What current will flow through a 36 ohm resistance when the following voltages are applied?

   a) 12V.
   b) 48V.
   c) 720V.
   d) 180V.
   e) 1.08V.
   f) 36mv.

5. Determine the resistivity of a 100 ft. conductor, 20 mils in diameter if its resistance is 50 ohms.

6. How long a wire with a resistivity of 25 ohms-circ mil per foot will be needed to produce a resistance of 250 ohms if the diameter is 5 mils?

2.3 Diagram



2.4 From the demonstration circuit two general conclusions can be drawn.

2.41 The current through each component is the same as the total current supplied
i.e. $I_T = I_1 = I_2 = I_3$

2.42 The potential difference across the circuit is equal to the sum of the potential differences across each component.
i.e. $V_T = V_1 + V_2 = V_3$

2.5 Effective resistance of the circuit.

2.51 From the equation for Ohm's law the voltage across a component can be determined by: $V = I \times R$

2.52 Substituting in the equation in 2.42 the equivalent I x R factors:

$$I_T R_T = I_1 R_1 + I_2R_2 + I_3R_3$$

2.53 But from 2.41 it is known that all the currents are the same and can thus be divided out leaving:

$$R_T = R_1 + R_2 + R_3$$

2.54 It can thus be stated that the effective resistance of a set of resistors connected in series is equal to the sum of the values of the individual resistances.

2.55 Example: Four resistors of 4,6,8, and 12 ohms respectively are connected in series to a 120 volt source. Find the effective resistance, current through the circuit and the voltage across each component.

(1) Effective resistance

R_T = 4 ohms + 6 ohms + 8 ohms + 12 ohms

R_T = 30 ohms

(2) Current in circuit

$$\frac{120\text{ V}}{I_T} = 30\text{ ohm}$$

$$I_T = \frac{120\text{ V}}{30\text{ ohms.}}$$

$$I_T = 4\text{ a.}$$

(3) Voltage across each component.

(a) 4 ohms

$$\frac{V}{4a} = 4\text{ ohms}$$

V = 4a x 4 ohms

V = 16 V.

(b) 6 ohms

$$\frac{V}{4a} = 6\text{ ohms}$$

V = 4a x 6 ohms

V = 24 V.

similarly for 8 ohms, V = 32 V. and for 12 ohms, V = 48 V.

3. Assignment - Worksheet on Series Circuits

LESSON 10 - Parallel Circuits

1. Check over worksheet on series circuits.

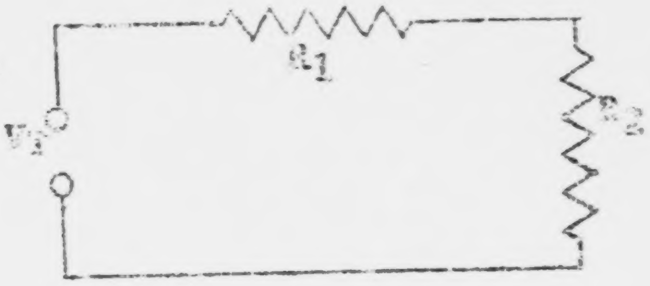
2. Paralled circuits
   2.1 A parallel circuit is a method of connecting electrical components so that there is more than one path for the current.
   2.2 Set up a demonstration parallel circuit with three resistances of different values, four ammeters, four voltmeters and a variable direct current source.

Name________________________________ Date______

Worksheet on Series Circuits

For each of the following circuits determine the requested quantities.

1.



R_T = ______

I_T = ______

V_1 = ______

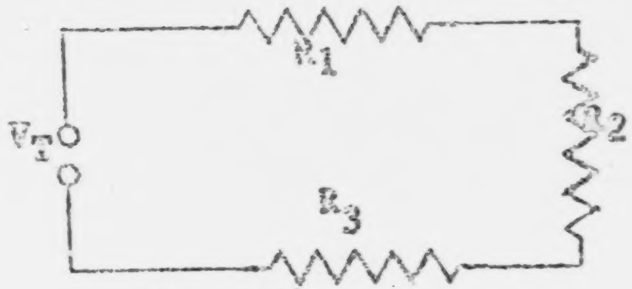
V_2 = ______

V_T = 36V

R_1 = 12 ohms

R_2 = 6 ohms

2.



R_T = ______

R_3 = ______

V_1 = ______

V_2 = ______

V_3 = ______

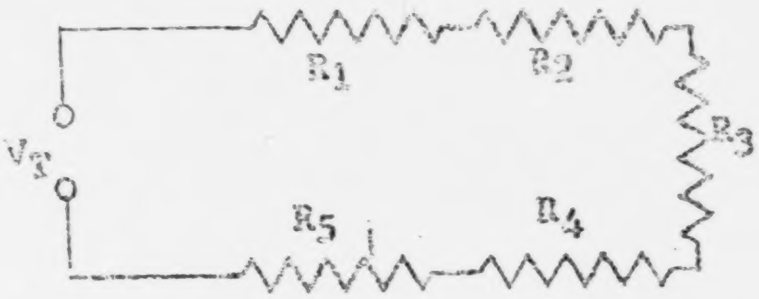
V_T = 24V

R_1 = 2 ohms

I_T = 3 amp.

R_2 = 4 ohms

3.


R_1
R_2
R_3
R_4
R_5
V_T

R_T = ______

V_T = ______

V_1 = ______

V_2 = ______

V_3 = ______

V_4 = ______

V_5 = ______

I_T = 0.8amp.

R_3 = 25 ohms

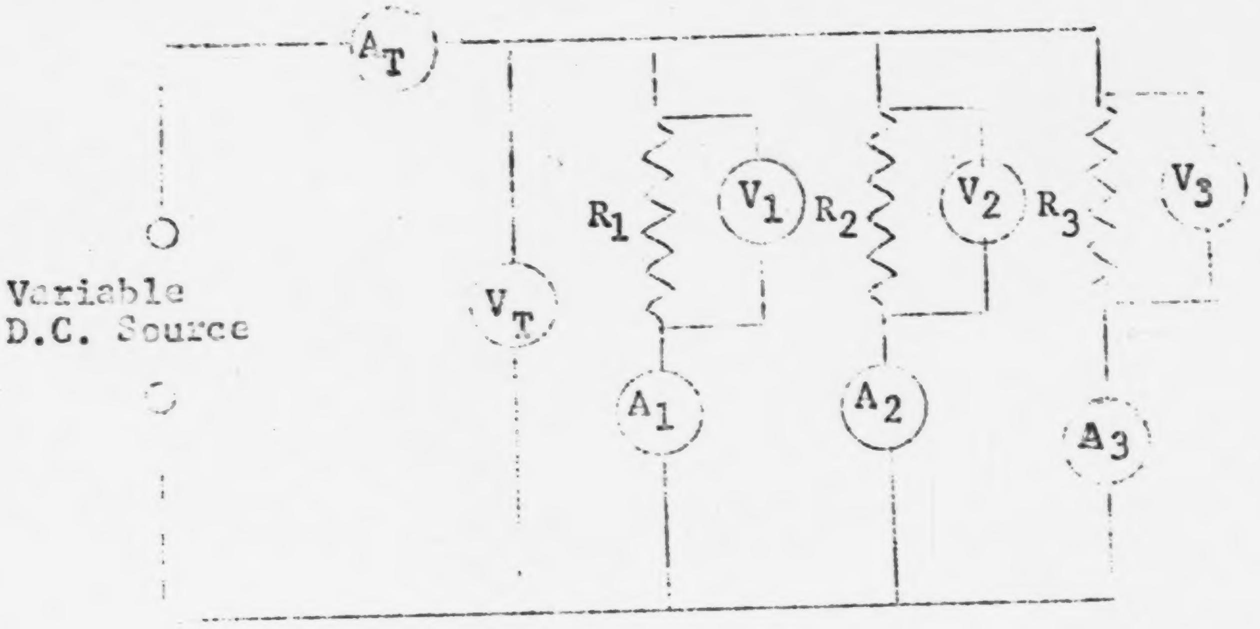
R_1 = 10 ohms

R_4 = 36 ohms

R_2 = 15 ohms

R_5 = 14 ohms

2.3 Diagram



2.4 From the demonstration circuit two general conclusions can be drawn.

2.41 The voltage across the whole circuit is the same as that across each component.
i.e. $V_T = V_1 = V_2 = V_3$

2.42 The total current is equal to the sum of the current through each branch of the circuit.
i.e. $I_T = I_1 + I_2 + I_3$

2.5 Effective resistance of the circuit.

2.51 From the equation for Ohm's Law the current through a component can be determined by: $I = \frac{V}{R}$

2.52 Substituting in the equation in 2.42 the equivalent V/R factors:

$$\frac{V_T}{R_T} = \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}$$

2.53 But from 2.41 it is known that all the voltages are the same and can thus be divided out leaving:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

2.54 It can thus be stated that the reciprocal of the effective resistance of a set of resistors connected in parallel equals the sum of the reciprocals of the individual resistors.

2.55 Example: Three resistors of 40, 30, and 120 ohms are connected in parallel across a 120 volt source. Find the effective resistance, total current and current through each component.

(1) Effective resistance.

$$\frac{1}{R_T} = \frac{1}{40 \text{ ohms}} + \frac{1}{30 \text{ ohms}} + \frac{1}{120 \text{ ohms}}$$

$$\frac{1}{R_T} = \frac{30 \times 120 + 40 \times 120 + 40 \times 30}{(40 \times 30 \times 120) \text{ ohms}}$$

$$\frac{1}{R_T} = \frac{9600}{144000 \text{ ohms}}$$

$$R_T = 15 \text{ ohms}$$

(2) Total current.

$$\frac{120 \text{ V}}{I_T} = 15 \text{ ohms}$$

$$I_T = \frac{120 \text{ V}}{15 \text{ ohms}}$$

$$I_T = 8 \text{ a.}$$

(3) Current through each component.

(a) 40 ohms

$$\frac{120 \text{ V}}{I} = 40 \text{ ohms}$$

$$I = \frac{120 \text{ V}}{120 \text{ ohms}}$$

$$I = 3 \text{ a.}$$

(b) 30 ohms

$$\frac{120 \text{ V}}{I} = 30 \text{ ohms}$$

$$I = \frac{120 \text{ V}}{30 \text{ ohms}}$$

$$I = 4 \text{ a.}$$

(c) 120 ohms

$$\frac{120 \text{ ohms}}{I} = 120 \text{ ohms}$$

$$I = \frac{120 \text{ V}}{120 \text{ ohms}}$$

$$I = 1 \text{ a.}$$

3. Parallel circuit application - house wiring.
    3.1 All appliances are designed to operate on a certain voltage. (120 V.)
    3.2 With a parallel wiring system each will have the rated voltage and will draw the current needed for operation.
    3.3 Discuss the danger of connecting too many applicances in paralled.

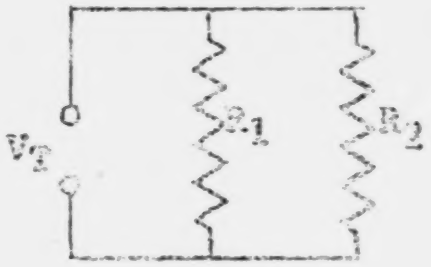
4. Assignment - Worksheet on paralled circuits.

Name________________________________ Date_____

Worksheet on Parallel Circuits.

For each of the following circuits determine the requested quantities.

1.



R_T = ________

I_T = ________

I_1 = ________

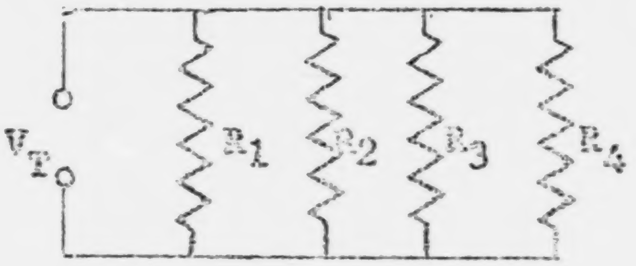
I_2 = ________

R_1 = 18 ohms

R_2 = 9 ohms

V_T = 27V

2.



R_T = ________

I_T = ________

I_1 = ________

I_2 = ________

I_3 = ________

I_4 = ________

V_T = 20V

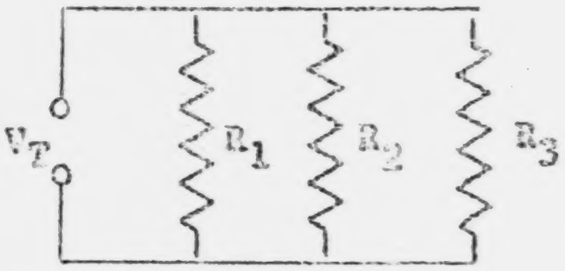
R_1 = 10 ohms

R_2 = 20 ohms

R_3 = 40 ohms

R_4 = 40 ohms

3.



R_T = ________

R_3 = ________

I_1 = ________

I_2 = ________

I_3 = ________

V_T = 72V.

I_R = 6 amp.

R_1 = 24 ohms

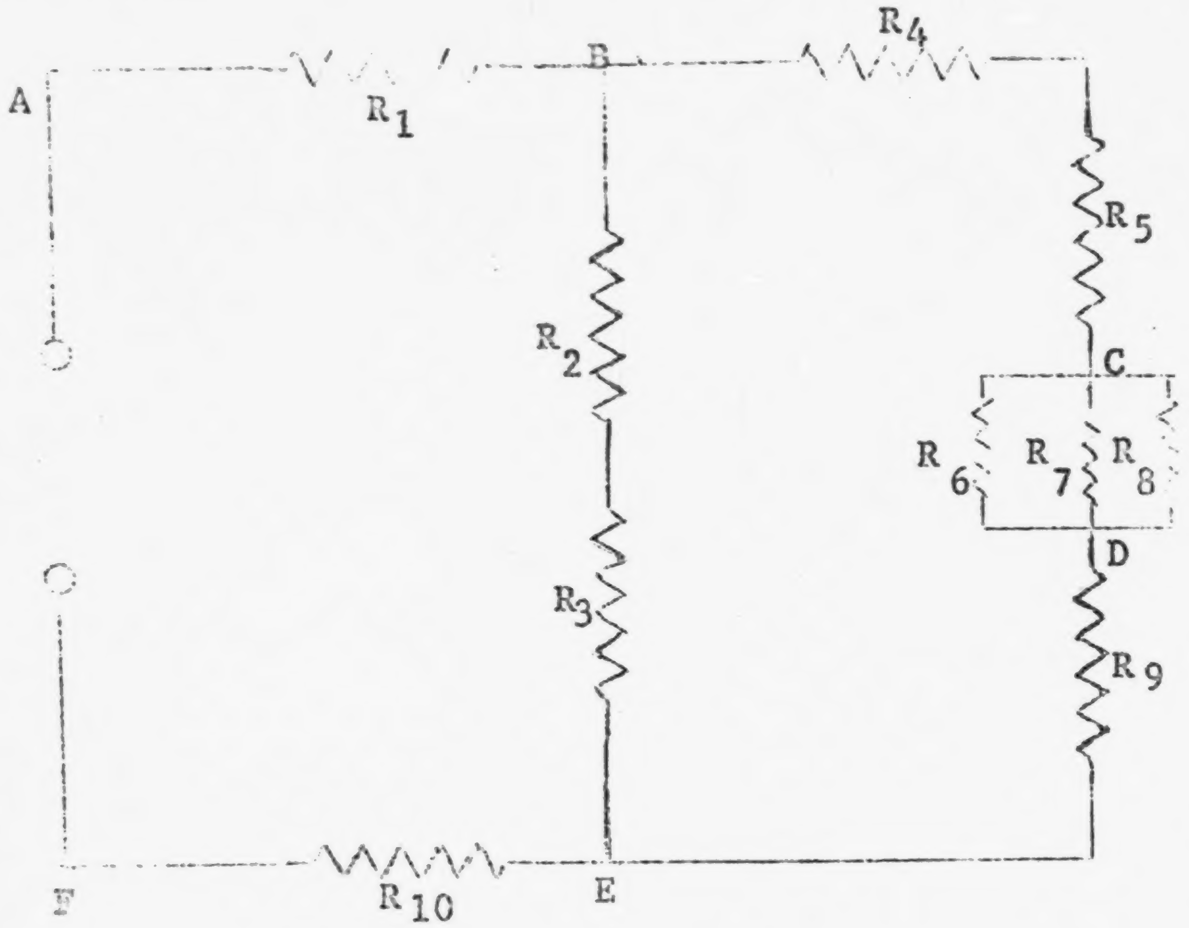
R_2 = 36 ohms

LESSON 11 - Networks

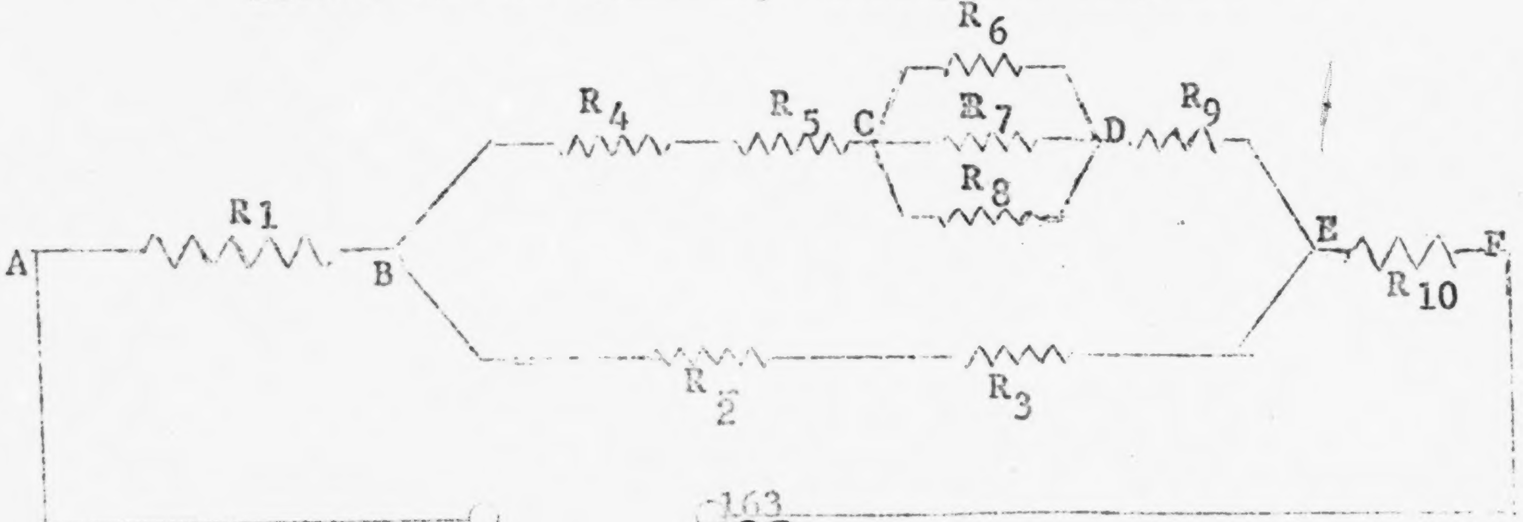
1. Check over worksheet on parallel circuits.

2. The network circuit.
   2.1 A combination of series and parallel circuits.
   2.2 Most circuitry involves networks of various degrees of complexity.

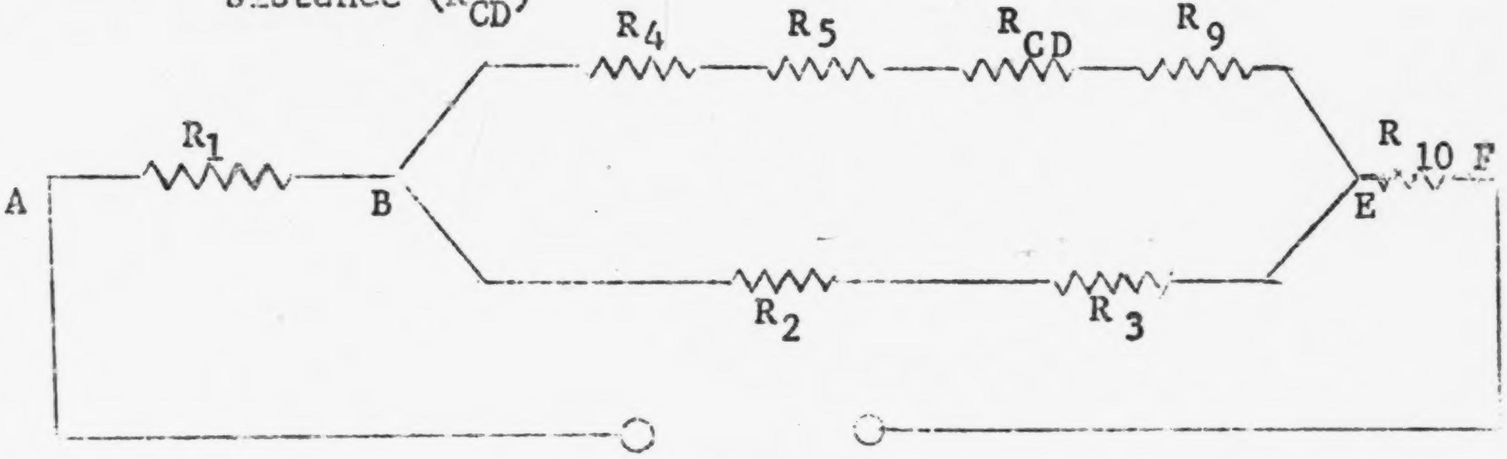
3. Solving a network problem.
   3.1 The network must be reduced to a single equivalen resistance.
   3.2 The circuit


A
R1
B
R4
R5
C
R2
R6
R7
R8
D
R3
R9
F
R10
E

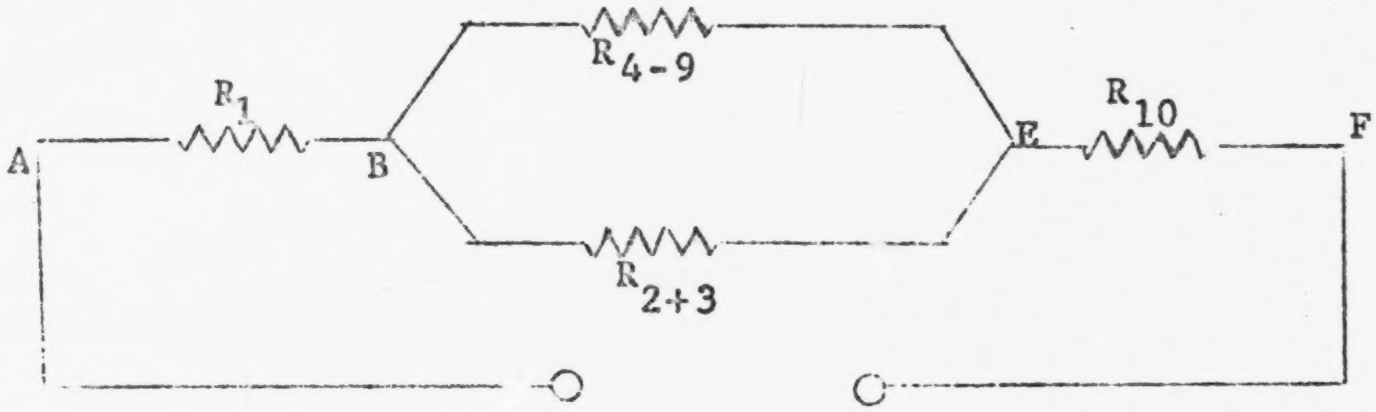
   3.3 It may help to redraw the circuit, if possible in a linear fashion which may clarify the diagram.


R6
R4
R5
C
R7
D
R9
R8
R1
A
B
E
R10
F
R2
R3

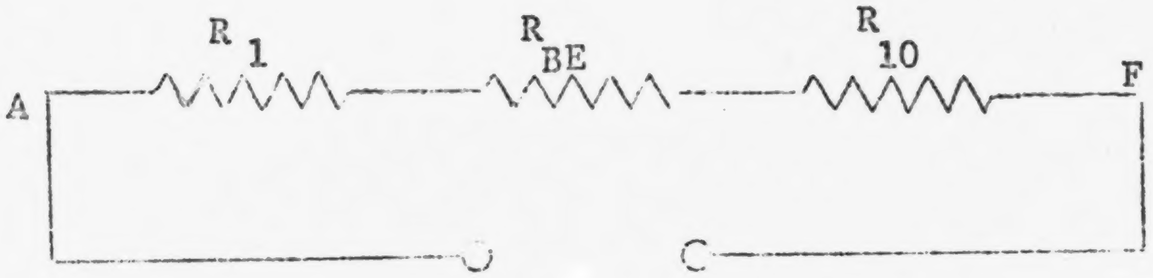
3.4 Reduce resistance from C to D to one equivalent resistance (R_{CD})


R4
R5
RCD
R9
R1
A
B
R 10 F
E
R2
R3

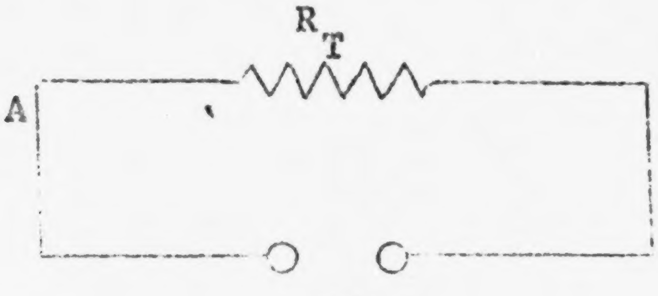
3.5 R_4, R_5, R_{CD}, and R_9 are in series and can be replaced by a single resistance R_{4-9} which equals their sum. R_2 and R_3 are treated in a similar manner.


R4-9
R1
A
B
E
R10
F
R2+3

3.6 The resistance from B to E can now by replaced by one equivalent resistance (R_{BE})


R 1
R BE
R 10
A
F

3.7 The effective resistance of the entire circuit can now be determined by adding R_1, R_{BE}, and R_{10}.



3.8 With R_T now determined the total current can be now calculated using Ohm's Law and voltage and current values for various parts of the circuit can be worked out.

4. Pass out worksheet on networks and have the group start working on them. They will continue with them in math class and complete for homework.

LESSON 12 - Methods of Measuring Resistance.

1. Check over worksheet on networks.

2. Voltmeter - ammeter method of resistance measurement.
    - 2.1 Method that has been used in laboratory activities and demonstrations.
    - 2.2 By measuring the voltage across the resistance and the current through it the value of the resistance can be determined by Ohm's Law.
    - 2.3 Problems with this method
        - 2.31 The ammeter does have some resistance so it will increase the total resistance of the circuit, thus reducing the current in the circuit.
        - 2.32 The voltmeter when connected in parallel with the resistor will cause the resistance then to be less, causing more current to flow in the circuit than before.
        - 2.33 These two factors may be only slight but will prevent the obtaining of very precise results.

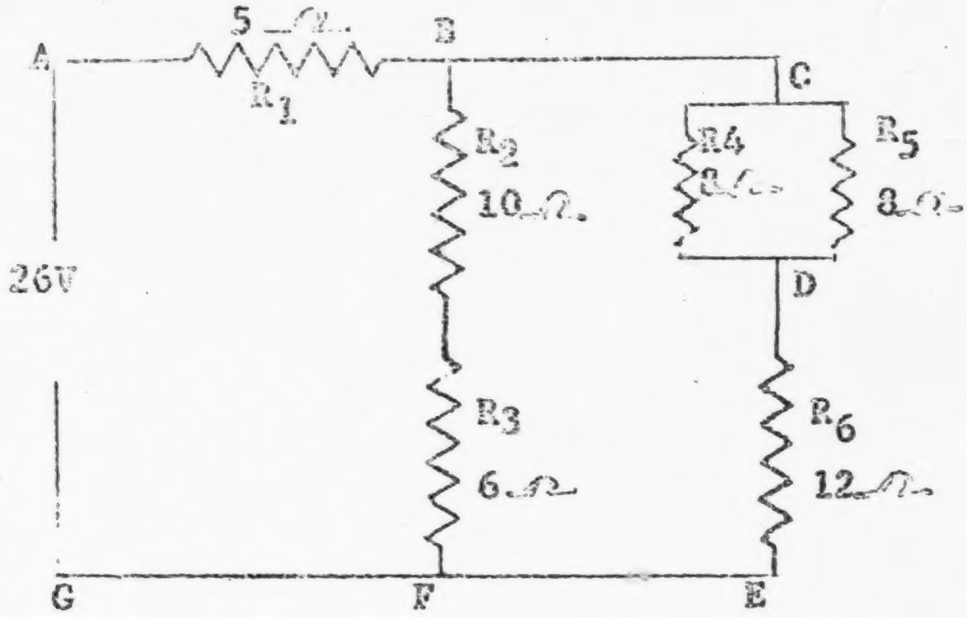
3. The Ohmmeter
    - 3.1 From examination of Ohm's Law it can be seen that, with a fixed voltage, the current is inversely proportional to the resistance.
    - 3.2 The ohmmeter utilizes this effect.
        - 3.21 A dry cell is attached in series to an ammeter and the resistance to be measured.
        - 3.22 The ammeter's scale is graduated in ohms instead of amperes.
        - 3.23 The higher the resistance the less current and consequently less needle deflection.
    - 3.3 This method is a quick, convenient method but is not very accurate.
    - 3.4 Used generally by technicians where approximate values are sufficient.

4. The Wheatstone Bridge
    - 4.1 A very accurate method of resistance measurement.

Name______________________________ Date_____

Worksheet on Networks

For each of the following circuits determine the requested quantities.


5 Ω
A
B
R_1
C
R_2
10 Ω
R4
8 Ω
R_5
8 Ω
26V
D
R_3
6 Ω
R_6
12 Ω
G
F
E

R_{CD} = ______

R_{CE} = ______

R_{BF} = ______

R_T = ______

I_T = ______

V_{AB} = ______

V_{BF} = ______

I_{CE} = ______

V_{R4} = ______

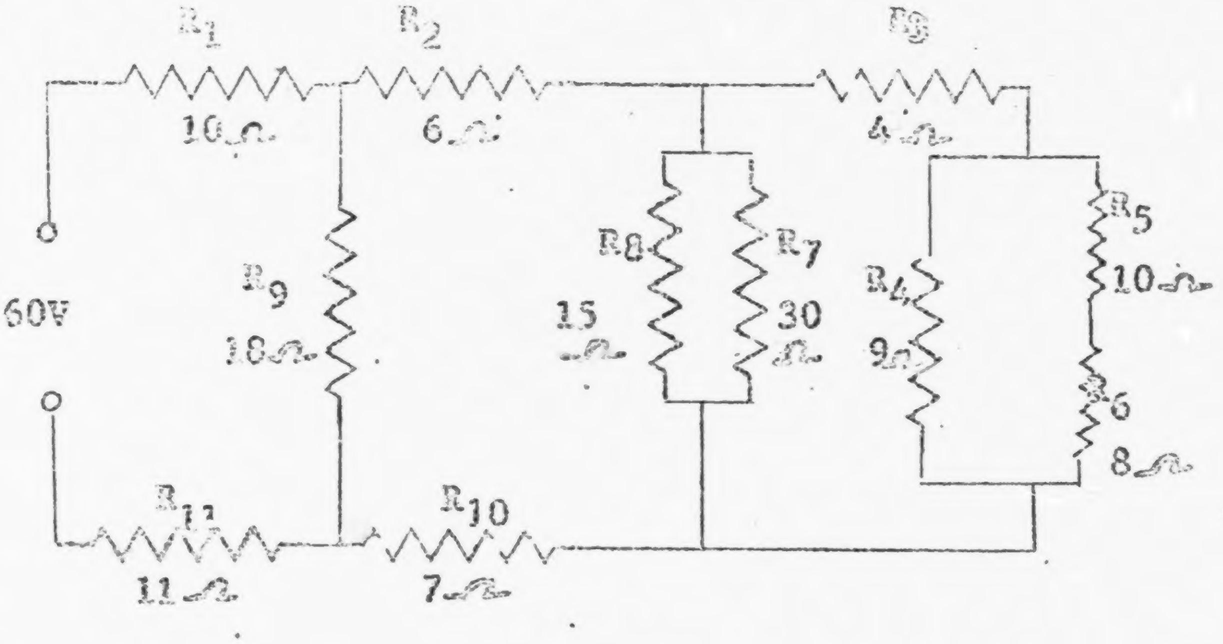
V_{R6} = ______

V_{R2} = ______

V_{R3} = ______

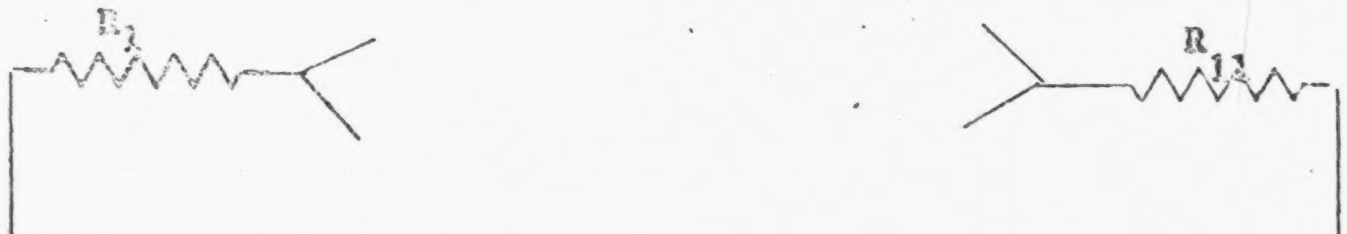
Name______________________________ Date______

Worksheet on Networks (continued)



R_1
10 Ω
R_2
6 Ω
R_3
4 Ω
60V
R_9
18 Ω
R_8
15 Ω
R_7
30 Ω
R_4
9 Ω
R_5
10 Ω
R_6
8 Ω
R_{11}
11 Ω
R_{10}
7 Ω

Reconstruct the network in a linear fashion.



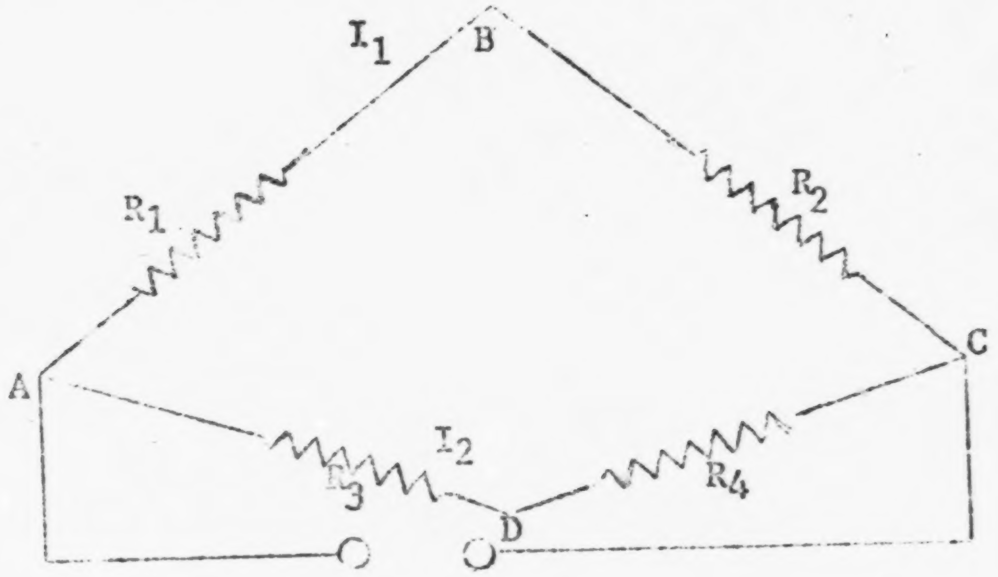
R_T = ________

I_T = ________

I_{R_2} = ________

I_{R_3} = ________

4.2 Basic circuit



4.3 Analysis of circuit

4.31 Voltage from A to B to C is the same as from A to D to C or $V_{AB} + V_{BC} = V_{AD} + V_{DC}$

4.32 If $V_{AB} = V_{AD}$

then $V_{BC} = V_{DC}$

4.33 By division

$$\frac{V_{AB}}{V_{BC}} = \frac{V_{AD}}{V_{DC}}$$

4.34 From Ohm's Law it is known that $V = IR$

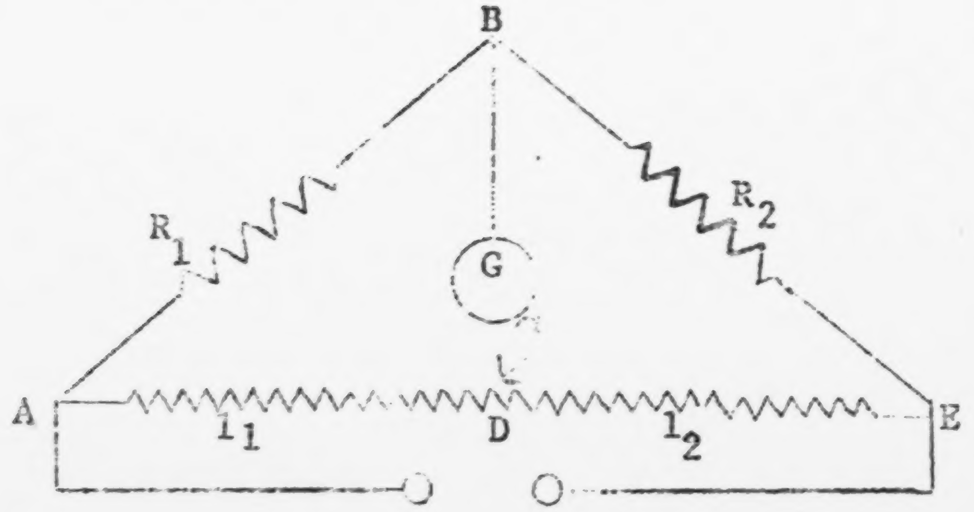
4.35 Substitute the respective I x R values in 4.33

$$\frac{I_1R_1}{I_1R_2} = \frac{I_2R_3}{I_2R_4}$$

4.36 By canceling

$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

4.4 If R_3 and R_4 are replaced by one long uniform conductor and a galvanuniter connected from point B to a sliding contact along the uniform conductor this diagram evolves:



4.41 When $V_{AB} = V_{AD}$ no current will flow from B to D (Galvanometer will read 0)

4.42 The resistance from A to D and D to C will become a factor of the lengths and the resistance ratio R_3/R_4 will reduce to l_1/l_2.

4.43 If R_1 is an unknown resistance an R_2 is a known value, R_1 can be determined by:

- 4.431 Adjusting contact D until the galvanometer reads 0.
- 4.432 Measuring distances l_1 and l_2.
- 4.433 Using the following relationship evolved from 4.36 the value of R_1 can be calculated

$$R_1 = R_2 \times \frac{l_1}{l_2}$$

4.5 Have a student form bridge set up and run several trials for the group.

5. Assignment - Study for test on direct current electricity.

LESSON 13 - Chemical Sources of Electrical Energy

1. Chemical reactions
   - 1.1 An atom has its lowest energy state when the outermost energy level is filled with electrons.
     - 1.11 For most atoms this is eight electrons.
     - 1.12 For hydrogen and helium it is only two.

1.2 Basically two ways for the atom to achieve this satisfied state.
1.21 Losing or gaining electrons.
1.211 If the atom needs only one or two electrons in the outer energy level it may take them from other atoms.
1.212 If the atom has only one or two electrons in the outer energy level it may give them up.
1.213 Example:
1.2131 Sodium has one electron in the outer energy level so it will release that electron and become a positive ion.
1.2132 Chlorine has seven electrons in the outer energy level so it will take the electron released from the sodium atom and become a negative ion.
1.2133 Because of the unbalanced charges two ions will attract each other and form the basic structure of sodium chloride (common table salt)

1.214 This mode of combining atoms is called ionic bonding.

1.22 Sharing electrons
1.221 Atoms with three to six electrons in the outer energy level frequently will share electrons with other atoms.
1.222 Example:
1.2221 Carbon has four electrons in the outer energy level and consequently needs four more.
1.2222 Oxygen has six electrons in the outer energy level and consequently needs two more.
1.2223 The oxygen atom will share two of its electrons with two of the carbon's electrons thus satisfying the oxygen's needs.
1.2224 A second oxygen atom will also share in a similar manner with the carbon atom thus satisfying the needs of the carbon atom.
1.2225 The compound thus formed is the familiar carbon dioxide gas.

1.223 This mode of combining atoms is called covalent bonding.

1.23 In actual practice it is not quite as simple as just outlined but is sufficient for the work at hand.

1.3 Oxidation - reduction reaction
1.31 A chemical reaction involving the excahnge of electrons.
1.311 Oxidation - the loss of electrons by an atom.
1.312 Reduction - the gain of electrons by an atom.

1.32 Example: zinc and hydrochloric acid.
1.321 When the zinc is placed in the acid hydrogen bubbles are released from the acid.
1.322 The zinc released electrons to the hydrogen ions in the acid.
1.323 The zinc was oxidized.
1.324 The hydrogen was reduced.

1.33 If the two actions could be caused to happen at different locations then an excess of electrons at one point and a shortage at the other could be developed.

2. The simple voltaic cell.
2.1 A way of obtaining the situation in 1.33.
2.2 Structure
2.21 Two plates of different metals (electrodes)
2.22 A conducting solution (electrolyte)
2.23 A container to hold the elements

2.3 Reaction
2.31 Electrodes - zinc and copper
2.32 Electrolyte - hydrochloric acid.
2.33 Action at zinc electrode
2.331 Zinc releases two electrons per atom to form the soluable zinc ion.
2.332 Zinc ions move into the electrolyte leaving electrons behind on the zinc plate.
2.333 This will continue until the plate becomes so negative that no more zinc atoms can release electrons.
2.334 Zinc electrode is now negatively charged and is called a cathode.

2.34 Action at the copper electrode
2.341 Positive hydrogen ions in the electrolyte are repelled from the area around the cathode by the zinc ions.
2.342 Hydrogen ions move toward the copper electrode.
2.343 At the copper electrode electrons are taken from the copper by the hydrogen ions.
2.344 The hydrogen ions become hydrogen atoms and form hydrogen molecules.

2.345 The copper electrode becomes positively charged due to the loss of electrons and is called the anode.

2.346 This action continues until the anode becomes positive enough to repel any more hydrogen ions.

2.35 The two electrodes now have developed concentrations of opposite charge.

2.36 If the two electrodes are connected by a conductor the electrons will move from the cathode to the anode.

2.361 As soon as this happens the reactions at the two electrodes can resume.

2.362 Thus a continuous supply of electrons may be developed.

2.4 Cell defects

2.41 Local action

2.411 Impurities in the zinc act as anodes.

2.412 This reduces the action at the cell's anode resulting in a loss of efficiency in the cell.

2.413 Prevention

2.4131 The cathode could be made with zinc of very high purity but would be expensive.

2.4132 A coating of mercury over the electrode acts as a shield to the impurities but allows the zinc ions to pass through. Process is called amalgamation.

2.42 Polarization

2.421 Hydrogen gas builds up as small bubbles around the anode.

2.422 Bubbles act as a shield, preventing the hydrogen ions from reaching the anode.

2.423 The output of the cell will be greatly reduced.

2.424 Prevention

2.4241 An oxidizing agent is introduced into the cell.

2.4242 This agent causes the hydrogen gas to be combined with oxygen to form water and thus clear up the problem.

3. Assignment - Write up definitions of new terms in notebook and study them.

Name____________________________________ Date____________________

Quiz on Lesson 13

Place you answers in the spaces provided.

1. Atoms may combine in two ways (a) by sharing electrons with another atom which is called .... bonding and (b) by electrical attraction due to the loss or gain of electrons which is called .... bonding.

1 a................

b................

2. A chemical reaction involving the exchange of electrons is called an oxidation-reduction reaction. (a) Oxidation is the ...... of electrons and (b) reduction is the ...... of electrons.

2 a................

b................

3. What are the three basic parts of a voltaic cell?

3(1)................

(2)................

(3)................

4. The positive electrode is called the ......

4. ....

5. The negative electrode is called the ......

5. ....

6. An oxidizing agent is used in the cell to prevent ......

6. ....

LESSON 14 - The Dry Cell and Storage Battery

1. Quiz on chemical reactions and the voltaic cell.

2. Voltaic cell action can occur with other material combinations.
   - 2.1 Have set up a series of cell demonstrations.
     - 2.11 Potatoes with two electrodes inserted
     - 2.12 A lemon cell
     - 2.13 A copper coin and a silver coin with wet blotting paper in between.

   - 2.2 Measure the voltages produced by these cells.

3. The dry cell.
   - 3.1 Have a large ignition type dry cell which has been cut in half for demonstration.
   - 3.2 Electrodes
     - 3.21 Cathode - zinc can
     - 3.22 Anode - carbon rod

   - 3.3 Electrolyte - moist paste of ammonium chloride and some zinc chloride.
   - 3.4 Depolarizing agent - manganese dioxide.
   - 3.5 Powdered carbon is included to reduce the internal resistance of the cell.
   - 3.6 Operation of the cell.
     - 3.61 Chemical reactions are essentially those of a simple voltaic cell.
     - 3.62 Potential difference developed is 1.5 volts and is independent of the size of the cell.
     - 3.63 Size of the cell determines the amount of current available from the cell.
     - 3.64 Polarization
       - 3.641 A heavy drain on the cell will result in the cell becoming polarized.
       - 3.642 If allowed to sat without a load the depolarizing agent will be able to restore the cell to full potential.
       - 3.643 Because of this the dry cell is designed primarily for situations requiring small currents or intermittent use.

4. The lead-acid storage cell
   - 4.1 A voltaic cell that can be recharged repeatedly to its original conditions.
   - 4.2 Demonstate a storage cell.
     - 4.21 Two clean lead plates immersed in sulpheric acid.
     - 4.22 Connect the two plates to a direct current source.

4.23 Have group observe the reaction and condition of the plates.
4.24 After charging, measure potential between the plates and then connect them to a door bell.

4.3 Structure of a commercial storage cell.
4.31 Cathode - a plate of spongy lead.
4.32 Anode - a lead grid filled with lead dioxide.
4.33 Electrolyte - sulphuric acid
4.34 Emf of cell - 2.2 volts

4.4 Discharge action
4.41 Cathode reaction - lead releases two electrons and combines with the sulfate ion to form lead sulfate.
4.42 Anode reaction - lead in the lead dioxide gains two electrons from the anode and combines with a sulfate ion to produce lead sulfate. The oxygen from the lead dioxide combines with hydrogen ions left in the acid to form water.

4.5 Charging action
4.51 If electric current is sent through the cell in the opposite direction the cell action is reversed and the cell restored to its original charged condition.
4.52 At the anode - electrons are removed from the lead in the lead sulfate and lead dioxide and sulphuric acid are formed.
4.53 At the cathode - electrons are added to the lead in the lead sulfate to form elemental lead and sulphuric acid.

4.6 Testing a storage battery
4.61 When charged the acid concentration is high and drops off as the battery is discharged.
4.62 The specific gravity of the electrolyte is used as an indication of the degree of charge.
4.621 Fully charged the specific gravity is about 1.300.
4.622 When discharged maybe as low as 1.100.

4.63 Show the hydrometer used for this purpose.

4. Assignment - In the text book on page 210 are nine simple rules for battery care and maintenance. Study these rules and your notes.

LESSON 15 - Storage Cells and Cell Combinations

1. Review concepts of a lead acid storage cell.

2. Nickel - cadmium cell.
2.1 More rugged than the lead-acid type.
2.2 Not subject to freezing when discharged.
2.3 Construction
2.31 Cathode - nickel hydroxide on a nickel-plated steel grid.
2.32 Anode - cadmium with some iron oxide on a steel grid.
2.33 Electrolyte - potassium hydroxide

2.4 Emf of cell is 1.2 volts.
2.5 Most frequently used in European manufactured automobiles.

3. Edison cell
3.1 Light-weight, strong and durable cell.
3.2 Internal resistance about ten times a lead-acid cell.
3.3 Cannot deliver the high starting currents needed for automobiles.
3.4 Holds charge well for long periods and can take considerable abuse.
3.5 Used to provide direct current in unattended locations and some electrically operated truck and fork lifts.
3.6 Construction
3.61 Cathode - iron oxide
3.62 Anode - hydrated nickel oxide and nickel
3.63 Electrolyte - potassium hydroxide

3.7 Emf of the cell is 1.3 volts.

4. Combination of cells.
4.1 Individual cells have fixed emfs and optimum current ratings.
4.11 All carbon-zinc dry cells have an emf of 1.5 V.
4.12 The No. 6 dry cell has an optimum current rating of 0.25 amperes of continuous current.

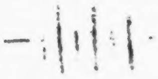
4.2 Cells may be combined in several ways to provide the emf necessary and also the current required for the load.
4.3 Series combinations
4.31 Positive terminal of one cell is connected to to the negative terminal of the next and so on.
4.32 The emf of the battery of cells is equal to the sum of the individual emf's of the cells.
4.33 The current in each cell is the same and equals the current in the load.
4.34 This type of battery is used for loads of higher emf demands than can be supplied by a single cell.

4.4 Parallel combination.
  4.41 All the positive terminals are connested together, and all the negative terminals connected together.
  4.42 The emf of the battery equals the emf of one cell.
  4.43 The total current delivered is divided equally among the individual cells.
  4.44 This type of battery is designed to be used where the load resistance is low and the current requirements are greater than that provided by a single cell.

4.5 Series--parallel combinations
  4.51 There are situations where the emf and current demands are both more that can be provided by a single cell.
  4.52 Under these circumstances both a series combination to provide emf and a parallel combination to provide the current is needed.
  4.53 Example: A load requires an emf of 4.5 volts and a current of 0.50 amperes. What combination of No.6 dry cells is necessary to satisfy this need?

4.5V
0.50A

    (1) The No.6 cell provides an emf of 1.5 V. and a current of 0.25 amperes.



    (2) To provide the emf a series of 3 cells is needed.
    (3) This series will provide 0.25 amp. so a second similar series is needed in parallel to provide the 0.50 amperes required.

    ← (4) Diagram

5. Assignment - Worksheet on cell combinations.

LESSON 16 - Force Exerted on a Current Carrying Conductor and the Galvanometer

1. Check over worksheet on cell combinations.

2. Force on a current carrying conductor.
  2.1 Demonstrate this force by using a large strong magnet with a small spacing between the pole faces. A length of heavy wire (12 gauge) is bent down on both ends at right angles. These two ends are inserted in small cups of mercury placed on each side of the opening between the poles. Direct current is applied to this wire through the mercury pools and, if in the right direction, the wire will jump out of the cups. (Note: A rather high current, better than 10 amperes will be necessary.)

Name________________________________ Date_____

Worksheet on Cell Combinations.

1. A No. 6 dry cell is designed to provide an emf of 1.5 volts and a current of 0.25 amperes. For the following load requirements determine the number of cells necessary and draw a diagram of their arrangement.

   a) 4.5V at 0.25a.

   b) 1.5V at 1.0a.

   c) 6.0V at 0.75a.

   d) 9.0V at 0.5a.

2. A small flashlight cell will provide an emf of 1.6 volts at a current of 0.08 amperes. For the following bad requirements determine the number of cells needed and draw a diagram of their arrangement.

   a) 1.6V at 0.32 amperes.

   b) 9.6V at 0.08 amperes.

   c) 4.8V at 0.24 amperes.

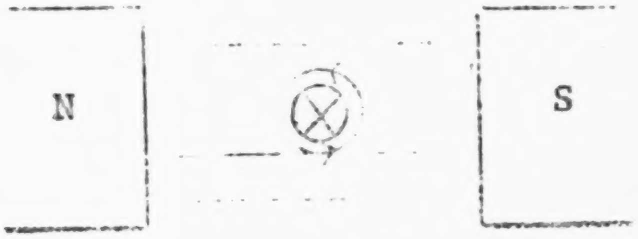
   d) 8.0V at 0.40 amperes.

2.2 Explanation of the reaction

  2.21 The current carrying wire has a magnetic field built up around it.

  2.22 This field interacts with the field of the magnet causing the wire to be pushed up.

  2.23 Diagram



    2.231 The two fields combine below the conductor.

    2.232 The two fields are in opposition above the conductor so one will tend to reduce the other.

    2.233 With less flux above than below there will be an upward force exerted on the wire.

2.3 Factors affecting the force.

  2.31 The strength of the magnetic field.

  2.32 The amount of current.

  2.33 The direction of the current.

3. Force exerted on a current carrying loop.

  3.1 If a rectangular loop of wire is inserted into the field a torque will be exerted on the loop.

    3.11 No force exerted on those portions parallel to the field. (ends of the loop)

    3.12 Force will be opposite on either side since the current is moving in opposite directions on each side.

  3.2 Loop will tend to rotate until the plane of the loop is at right angles to the field.

  3.3 If the loop has to work against a spring to rotate then the degree of rotation will be dependent upon the amount of current flowing through the loop.

  3.4 The direction the loop rotates will be dependent upon the direction of the current in the loop.

  3.5 With more turns in the loop the interaction force will be greater.

  3.6 Develop with the group the idea that here is a way of detecting the presence of an electric current and determining the direction of the current.

  3.7 With a coil it may be easily seen that the coil becomes a magnet with a N and S pole and the field of this magnet will attempt to align itself with that of the permanent magnet.

4. The galvanometer

4.1 Display and explain the purposes of the parts of a simple suspension type galvanometer and the more common panel type meter movement.

4.2 Purposes of a galvanometer
  4.21 Needle is set in center of the scale so that the direction of needle movement indicates the direction of the current.
  4.22 May detect very weak electric currents.
  4.23 May be used to measure weak currents.

4.3 Current sensitivity
  4.31 The deflection of the needle is proportional to the current.
  4.32 The current sensitivity is the amount of current needed to produce a deflection of one scale division.
  4.33 Equation

$$K = \frac{I_M}{S}$$

where K is the current sensitivity in microamperes per scale division, I_M is the current in the meter in microampheres and S is the number of scale divisions.

4.4 Voltage sensitivity
  4.41 The meter coil has some resistance.
  4.42 In order for current to move through the meter a small amount of voltage is required.
  4.43 The voltage necessary to maintain the current is called the voltage sensitivity.
    4.431 It is the voltage necessary to produce a deflection of one scale division.
    4.432 From Ohm's Law it can be seen that the voltage sensitivity will equal the current sensitivity times the coils resistance.
    i.e. Voltage Sensitivity = $K R_M$
    where K is the current sensitivity and R_M the resistance of the meter.

    4.433 Voltage sensitivity is expressed in microvolts per scale division.

4.5 Example: What current is required for full-scale deflection (25 division) of a galvanometer with a current sensitivity of 100 microamps per division?

$$K = \frac{I_M}{S}$$

$$100 \text{ microamps/division} = \frac{I_M}{25 \text{ divisions}}$$

I_M = 25 division x 100 microamps/division
I_M = 2,500 micoramp.

What voltage would produce this deflection if the resistance of the meter is 15 ohms?

$V_M = I_M R_M$

V_M = 2,500 microamp x 15 ohms.
V_M = 37,500 microvolts or 37.5 mv.

5. Assignment - Study for test on chemical sources of electricity.

LESSON 17 - Voltmeters, Ammeter and Multi-meters

1. Galvanometer is the basic electrical measuring device.
   1.1 Review basic operation of a galvanometer.
   1.2 Voltmeters and ammeters use the galvanometer movement with additional circuitry to perform their tasks.

2. The D.C. voltmeter
   2.1 Basically a galvanometer with a high resistance connected in series with the meter's coil.
   2.2 The value of the resistance is selected so that when the meter is connected across the points to be measured only the small current required to deflect the needle will flow through the meter.
      2.21 The galvanometer in the example in Lesson 16 required 2,500 microamperes for full scale deflection.
      2.22 If a voltmeter is to be made to measure 100 V. on full scale deflection then resistance of the meter must be high enough to allow only 2,500 microamperes to flow when connected across the 100 V. potential difference.
      2.23 i.e.

$$R = \frac{100\ \text{V}}{2.5 \times 10^{-3}\text{a}}$$

$$R = 40{,}000 \text{ ohms.}$$

      2.24 But the meter movement already had 15 ohms resistance so the additional resistance necessary is 40,000 - 15 or 39,985 ohms.

   2.3 Voltmeter sensitivity
      2.31 A way of estimating the loading effect of the meter.

2.32 Expressed in terms of the resistance required per volt of potential difference.

2.33 The meter in discussion will have a voltage sensitivity of 40,000 ohms divided by 100 volts or 400 ohms per volt.

2.34 If the meter is placed across a load whose resistance is near that of the meter it will very seriously affect the operation of the circuit.

2.35 The better quality meters in general have a sensitivity of 20,000 ohms per volt.

3. The D.C. ammeter

3.1 The galvanometer movement can be used as an ammeter just by calibrating the scale.

3.2 The movement under discussion would only be capable of reading to 2.5 ma.

3.3 For use with higher currents a low resistance (shunt) in parallel is used to carry the rest of the current, allowing only the 2.5 ma. to pass into the meter coil.

3.4 If the meter was to read 10 amperes on full scale deflection, the shunt would have to carry 10 amp - 2.5 ma or 9.9975 amperes.

3.5 Calculating the shunt resistance

3.51 Since the meter movement and shunt are in parallel then $V_M = V_S$ where V_M is voltage across the meter and V_S is the voltage across the shunt.

3.52 From Ohm's Law it can be seen that:

$I_M R_M = I_S R_S$

where I_M is the current in the meter, I_S is the current in the shunt, R_M is the meter resistance and R_S is the shunt resistance.

3.53 The current in the shunt is the difference between the current in the circuit and the current in the meter or $I_S = I_T - I_M$ where I_T is the circuit current.

3.54 The shunt resistance can then be calculated by:

$$R_S = \frac{I_M R_M}{I_T - I_M}$$

3.55 For the set up in 3.4 then

$$R_S = \frac{2.5 \times 10^{-3} a \times 15 \text{ ohms}}{9.9975 a}$$

$$R_S = 0.00375 \text{ ohms}$$

4. Multi-purpose meters

4.1 With the use of switching mechanisms multi-range and multi-purpose meters can be developed with only one meter movement.

4.2 Illustrate this type of set up with the R.C.A. VOM dynamic demonstrator a bread board layout of R.C.A.'s volt-ohm milliameter.

3. Assignment - Worksheet on meters.

LESSON 18 - Electromagnetic Induction

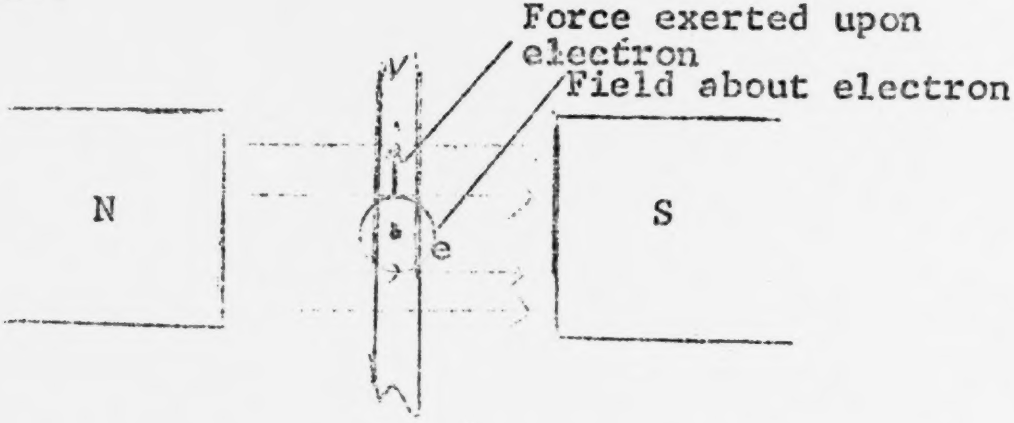
1. Go over worksheet on meters.

2. The work of this lesson should be preceded by the laboratory exericse on electromagnetic induction using Cenco's Gilley Induction Coils.

3. How can an emf be induced in a conductor?
    - 3.1 By moving a conductor through a magnetic field.
    - 3.2 By moving a magnetic field past a conductor.

4. What determines the magnitude of the induced emf?
    - 4.1 The speed of the conductor as it moves through the field.
    - 4.2 The speed of the magnet as it passes the conductor.
    - 4.3 The number of turns of wire in the conductor.

5. Explanation of the action.
    - 5.1 Consider a straight conductor moving downward in a magnetic field.
    - 5.2 Diagram



    - 5.3 The free electrons within the conductor will be moving downward and will have set up around them a magnetic field.
    - 5.4 This field about the electron will interact with the magnetic field of the magnet resulting in a force being exerted upon the electron.
    - 5.5 If the conductor is connected to a load a current will flow through the load.

Name________________________________ Date______

Worksheet on Meters.

1. A gabanometer has a current sensitivity of 5 microamperes per scale division and the scale is divided into 25 divisions on each side of the zero. If the resistance of the meter coil is 50 ohms find the resistance of the shunt needed to use this meter to read the following currents at maximum diflection.

   a) 1 milliamper

   b) 100 milliamperes

   c) 1 ampere

   d) 5 amperes.

2. The meter movement in #1 is to be used as a voltmeter. What series resistance will be needed to have the meter read the following voltages at maximum deflection?

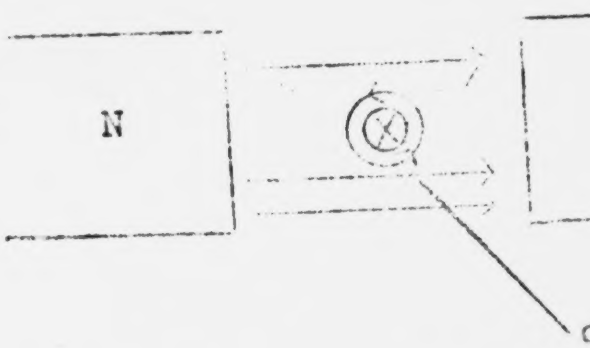
   a) 1 Volt

   b) 5 Volts

   c) 100 Volts

   d) 1000Volts

5.6 If the diagram is viewed from the front it will appear as follows:



current moves away from observer.

5.61 The magnetic field about the conductor due to the induced current reinforces the field in the direction that the conductor is moving and opposes the field behind the conductor.

5.62 The result of this is a field interaction which develops a force which opposes the motion of the conductor.

5.63 The work done in overcoming this force results in the increased potential energy of the free electrons.

5.7 Lenz's Law - The direction of the induced current is always such as to oppose the cause of the induction. (Check over results from the lab to confirm this.)

5.8 Magnitude of the induced emf.

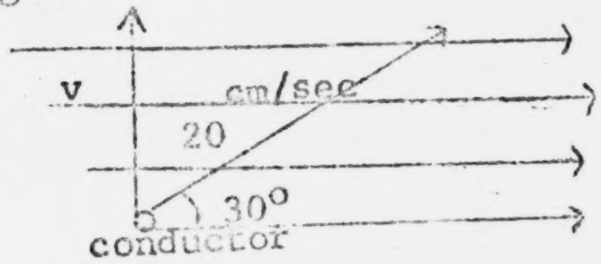
5.81 Determined by the number of lines of force cut by the conductor per unit time.

5.811 Maximum number of lines are cut when conductor moves at right angles to the field.

5.812 If movement is other than a right angle, the number of lines cut will be less.

5.813 Example: A conductor is moving at 20 cm/sec at an angle of 30° with a field which has 100 lines per cm. How many lines are cut by the conductor per second?

Diagram:



To find the number of lines cut, the velocity at right angles to the field must be known. This can be found by use of the sine function where the desired component (v) equals the velocity times the sine of the angle the velocity vector makes with the field.

i.e. $v = 20 \text{ cm/sec} \times \sin 30^{\circ}$
$v = 20 \text{ cm/sec} \times 0.500$
$v = 10 \text{ cm/sec}$

The number of lines cut per second will then equal this component velocity times the number of lines per unit distance.

i.e. # lines = 10 cm/sec x 100 lines/cm
# lines = 1000 lines/sec

5.814 Since the magnitude of the induced emf depends upon the number of lines of force cut per unit time it can be concluded that the emf is also a factor of the sine of the angle which the direction of the moving conductor makes with the field.

5.82 Determined also by the number of conductors which cut the field. (If two conductors are connected in series the emf will be twice that if the one conductor.)

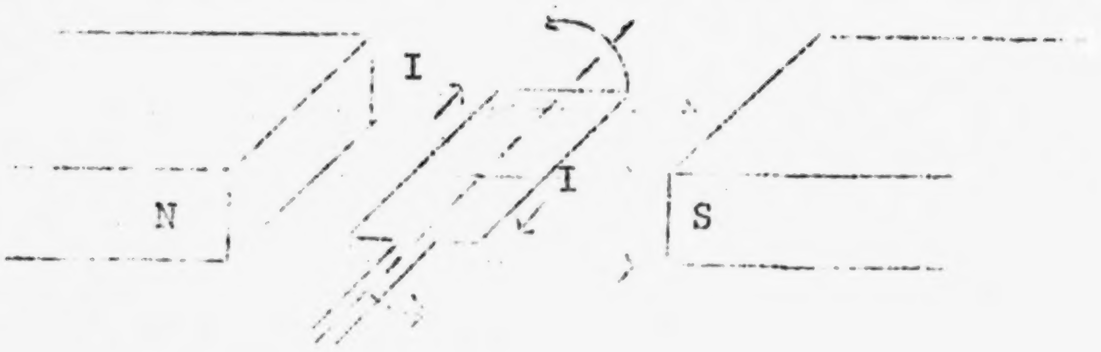
6. Assignment - Study notes and definitions of terms.

LESSON 19 - The Alternating Current Generator

1. Review the factors involved in inducing an emf.

2. Simple generator
   2.1 Demonstrate the generator action by rotating in a magnetic field a coil of wire which is connected to a galvanometer.
   2.2 Explanation of the action
      2.21 Consider a single loop rotating in a magnetic field.

2.22 Diagram



2.23 The current in the left hand portion is moving away while that in the right hand section is moving toward the observer.

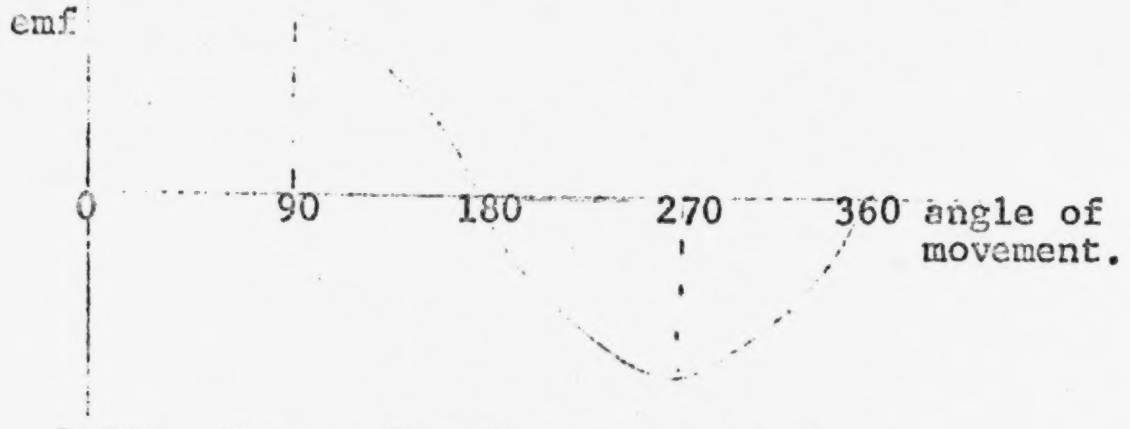
2.24 When the coil is moving at right angles to the field the induced emf is a maximum, when motion is parallel to the field the emf will be zero.

2.25 If this loop is connected to the load the current will be zero when emf is zero and build up to a maximum and decrease to zero again.

2.26 As the loop continues around the current in the load will behave in a similar manner to 2.25 but now in the opposite direction.

2.27 The increase and decrease of the current will follow a sine curve relationship. (Lesson 18 part 5.81)

2.28 Graph of relationship:



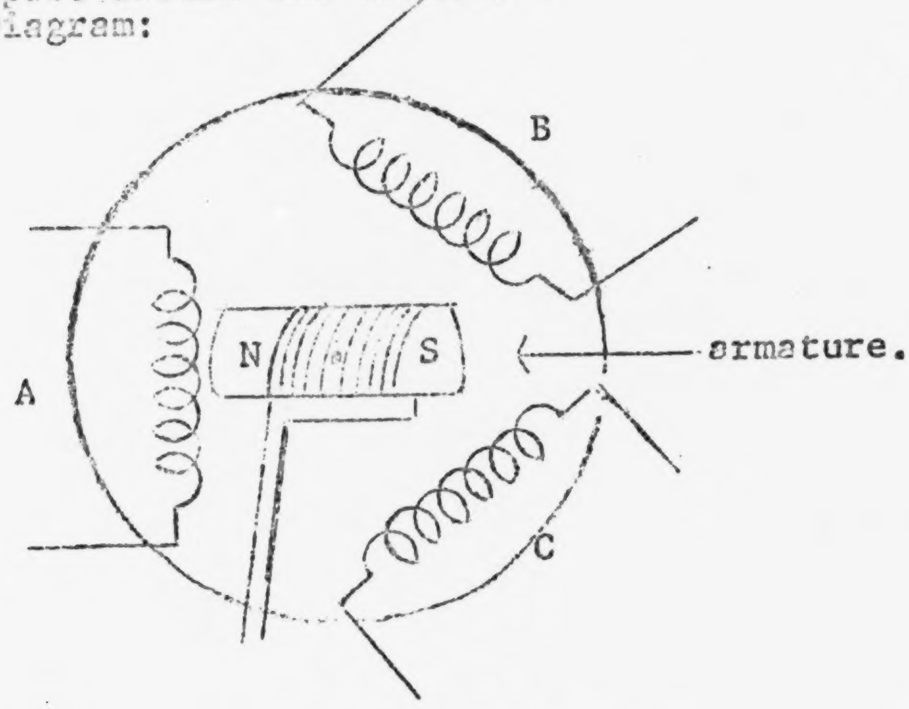
2.281 The result of one turn of the loop.

2.282 This is called one cycle.

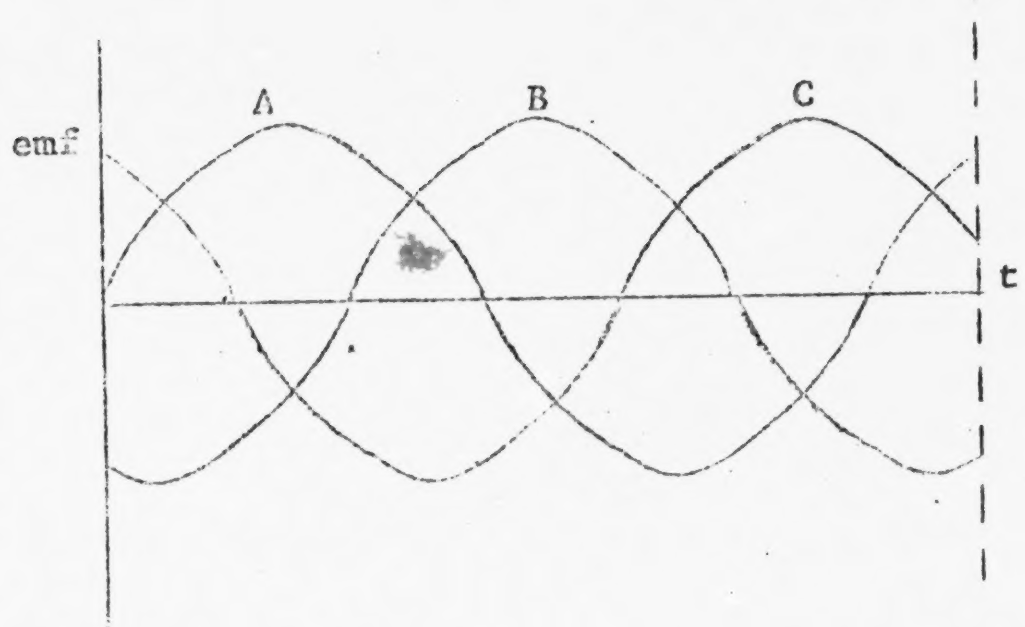
2.283 Frequency is the number of cycles which occur in a second.

2.3 Removal of current from loop - discuss structure and operation of slip rings.

3. Poly-phase generators
   - 3.1 In most commercial generators the armature is an electromagnet and the emf is induced in the stator coils.
   - 3.2 In most systems more than one set of stator coils is employed.
     - 3.21 The coil sets are uniformly spaced around the armature.
     - 3.22 Called a poly-phase generator.
     - 3.23 Results in smoother power generation and more economical operation (similar in idea to the one cylinder engine as compared to a four cylinder engine)
   - 3.3 The three phase generator
     - 3.31 Type most commonly used in power stations.
     - 3.32 Three sets of stator coils spaced 120° apart around the armature.
     - 3.33 Diagram:



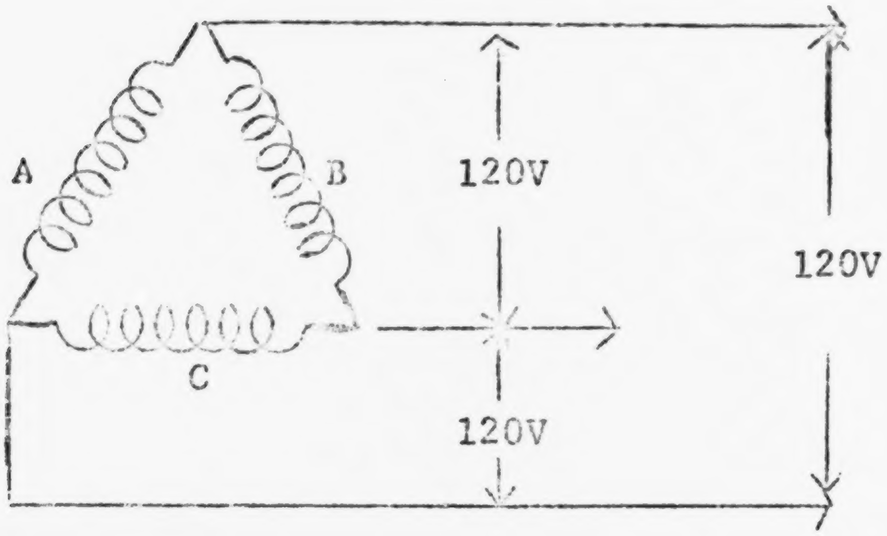
3.34 Voltage output



3.35 The output from this type of generator is so connected that only three wires are necessary.

3.351 Delta connection

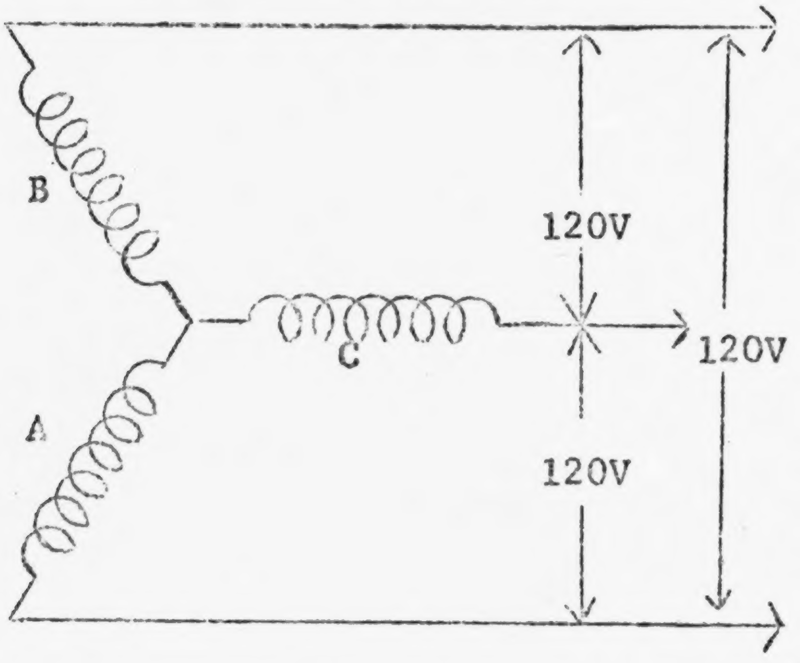
3.3511 Diagram:



3.3512 The voltage to the load across any two leads equals the emf of the coil.

3.352 Y connection

3.3521 Diagram:



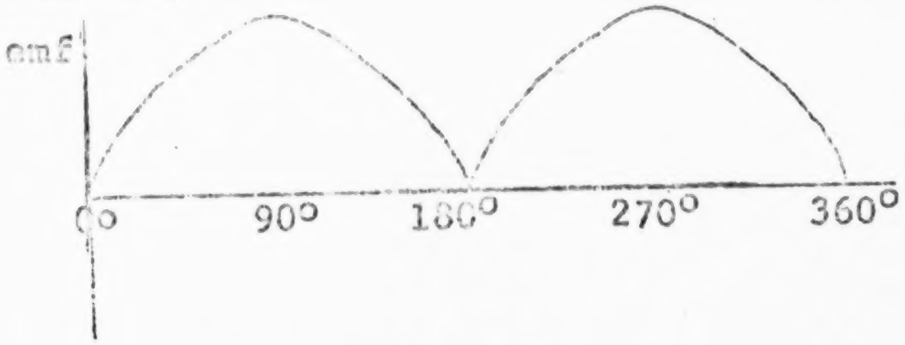
3.3522 In this arrangement the voltage to the load across any two leads equals the emf developed across two stator coils in series.

4. Assignment - Study notes and definitions of terms.

LESSON 20 - The Direct Current Generator

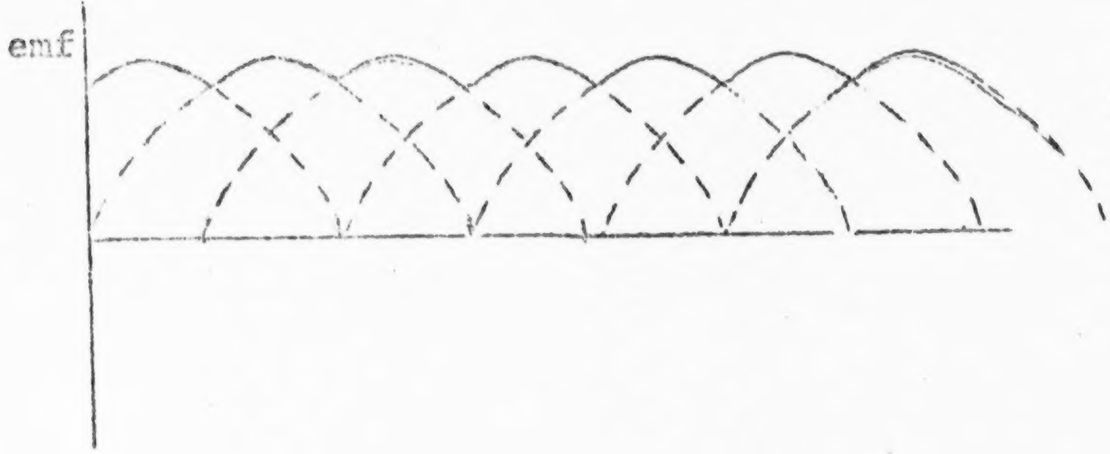
1. Review basic concepts of the a.c. generator.

2. Simple d.c. generator.
   - 2.1 Action in rotating coil is the same as the a.c. generator.
   - 2.2 A split-ring commutator is used to connect the coil to the external circuit rather than the slip rings.
   - 2.3 Graph of output:



   - 2.31 The emf still is a varying one, following basically a sine curve relationship.
   - 2.32 The difference is that the emf increases and decrease always in the same direction.

   - 2.4 To provide a smoother current
     - 2.41 Additional electrical circuitry maybe employed.
     - 2.42 Multiple windings
       - 2.421 The armature maybe wound with several coils of wire each attached to its own pair of commutators.
       - 2.422 The brushes will be in contact with this set of commutators only when the coil is cutting the maximum lines of force.
       - 2.423 Graph of output:



3. D.C. generators are self excited.

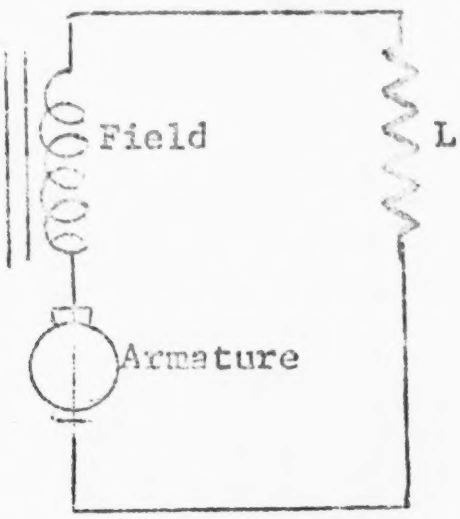
3.1 Part of the induced current is used to energize the field coil.

3.2 Series-wound generator

3.21 Field, armature and load are wired in series.

3.22 All the generated current passes through the field windings.

3.23 Circuit diagram:



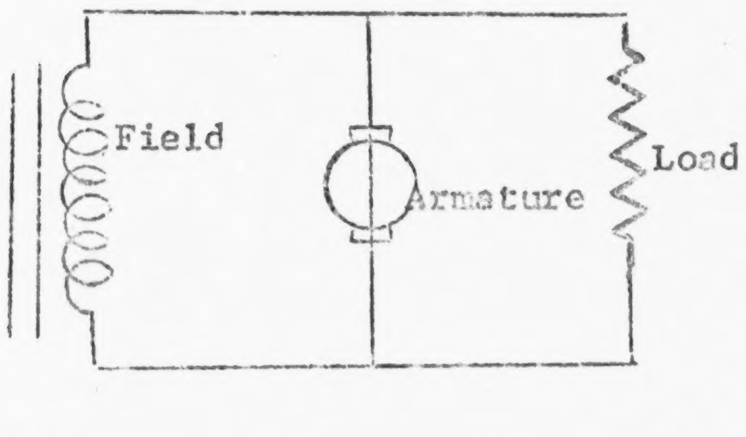
3.24 An increase in load results in an increased magnetic field consequently a greater induced emf.

3.3 Shunt-wound generator

3.31 Field is in parallel with the armature.

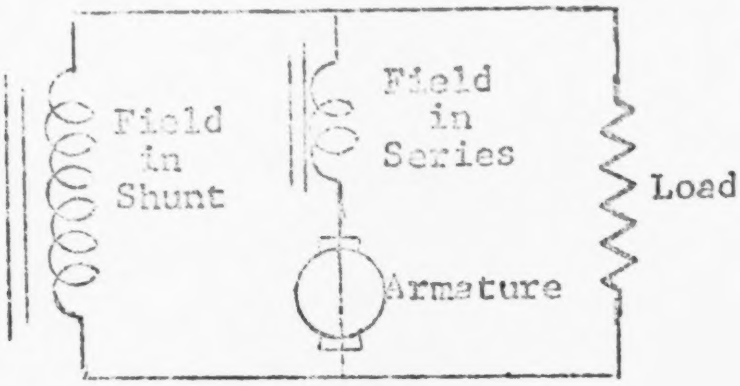
3.32 Only a portion of the generated current passes through the field.

3.33 Diagram:



3.34 An increase in load will result in a decrease in field consequently a decrease in the induced emf.

3.4 Compound-wound generator.
  3.41 Two field windings are employed, one in parallel and one in series.
  3.42 The potential difference across the load will remain fairly constant.
  3.43 Proper selection of turns of each type results in a constant magnetic field under varying load conditions.
  3.44 Diagram:



4. Assignment - Study for test on Electromagnetic Induction and generators

LESSON 21 - The Transformer

1. Review work from lab on electromagnetic induction concerning the inducing of a current in one coil by a changing current in another.

2. Purposes of a transformer.
  2.1 To provide electric current at higher potential.
    2.11 There will be a corresponding decrease in current.
    2.12 Called a step-up transformer.

  2.2 To provide electric current at lower potential.
    2.21 There will be a corresponding increase in current.
    2.22 Called a step-down transformer.

3. Basic structure of a transformer.
  3.1 Iron core
    3.11 Concentrates the magnetic field.
    3.12 Laminated of thin sheets to reduce losses due to induced currents in the core.

  3.2 Primary coil - coil to which a-c current is applied.
  3.3 Secondary coil - coil from which a-c current is obtained.

4. Operation of a transformer.

4.1 The alternating current in the primary has a continuously changing magnetic field about it.

4.2 This field is concentrated by the iron core and will be cutting the conductor in the secondary coil.

4.3 This continual cutting of the secondary coil by the magnetic field from the primary induces an emf in the secondary coil.

4.4 Magnitude of the induced emf.

4.41 Depends upon the relationship between the number of turns in the primary and number of turns in the secondary.

4.411 Same number of turns - emf is the same in the secondary as the primary.

4.412 Fewer turns in the secondary - emf is less in the secondary than in the primary.

4.413 More turns in the secondary - emf is more in the secondary than in the primary.

4.42 Calculating the emf in the secondary.

4.421 The voltage ratio should ideally equal the turns ratio.

4.422 Equation:

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$

where: V_S is the secondary voltage,
V_P is the primary voltage,
N_S is the number of turns in the secondary and
N_P is the number of turns in the primary.

4.5 Current in the secondary.

4.51 Power in an electrical circuit is determined by the product of the voltage and current. (Provided there is no inductive or capacitive reactances)
i.e. $P = V \times I$

4.52 Ideally the power input to the transformer and the power output should be equal.
i.e. $P_P = P_S$

or $V_P I_P = V_S I_S$

4.53 By algebraic munipulation

$$\frac{V_P}{V_S} = \frac{I_S}{I_P}$$

4.54 But in 4.422 it was shown that the voltage ratio was equal to the turns ratio so:

$$\frac{N_P}{N_S} = \frac{I_S}{I_P}$$

4.55 This relationship shows that the gain in voltage will result in a lowering of current and also the reverse.

4.6 Transformer losses
  4.61 Copper losses
    4.611 Energy losses due to the resistance of the conductors.
    4.612 Results in heat

  4.62 Hysteresis losses
    4.621 Energy which is consumed in reversing the magnetic polarity of the core.
    4.622 Proper selection of core material will reduce this loss.

  4.63 Eddy current losses
    4.631 Electric currents which are set up in iron core due to the changing flux.
    4.632 Laminating the iron core reduces this to a minimum.

5. D.C. Transformer - The induction coil.
  5.1 D.C. current cannot be used in a transformer because the magnetic field does not change.
  5.2 If the current is periodically interrupted there will then be a changing magnetic field established.
  5.3 This changing field will induce an alternating emf in the secondary.
  5.4 Discuss the construction and operation of:
    5.41 High voltage induction coil.
    5.42 Automotive ignition system.
    5.43 Vibrators for automobile radios.

6. Assignment - Worksheet on transformers.

LESSON 22 - Power Transmission and Distribution

1. Review worksheet on transformers.

2. Power transmission and distribution.
  2.1 In the generating station the current produced generally has an emf of about 13,200 volts.

Name________________________________ Date________________

Worksheet on Transformers

1. The primary of a transformer has 240 turns of wire and is connected to a 120 volt source. How many turns are needed in the secondary to obtain the following output voltages?

   a) 4 V. d) 720 V.

   b) 80 V. e) 12 kv.

   c) 560 V. f) 120 V.

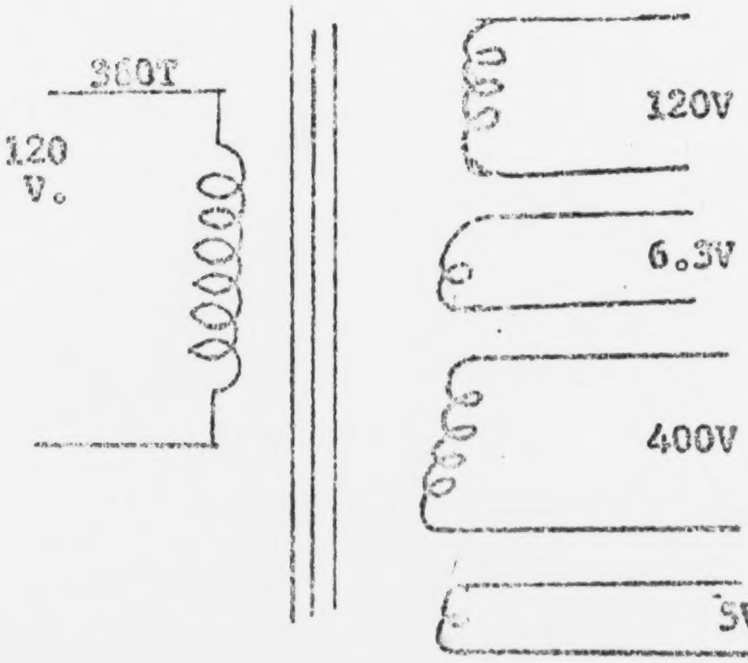
2. What voltages would be obtained from the transformer in #1 if the secondary had the following numbers of turns?

   a) 60 d) 160

   b) 360 e) 720

   c) 12,000 f) 4,200

3. Frequently a single primary winding will be used to activate several secondaries. The following diagram illustrates this set up. Determine the number of turns in each secondary coil.



120V , ______turns.

6.3V , ______turns.

400V , ______turns.

5V , ______turns.

2.2 For distribution this may be stepped up to as high as 250,000 volts.

2.21 Amount of step-up is dependent upon the distance the power is to be carried.

2.22 The higher the voltage the lower the current and consequently the less loss due to the resistance of the transmission lines.

2.3 Area substation.

2.31 The transmission voltage is stepped down to a lower potential (possibly 26,400 V).

2.32 This lower voltage is then transmitted along lines to the distributing substations.

2.4 Distributing substations

2.41 Voltage is further reduced to 2300 or 400 volts.

2.42 This is a safe voltage for distribution through heavily populated areas.

2.5 Distribution to the home.

2.51 On the utility poles additional transformers are used.

2.52 Reduce the voltage of the lines to the amount needed for home use.

2.53 A three wire output is used.

2.531 120 V between the center and either side wire.

2.532 240 V between the two side wires.

3. Distribution of current into the home.

3.1 Three wire input to the house.

3.2 Wires pass through the meter to the distribution panel.

3.3 The distribution panel contains fuses or circuit breakers.

3.31 Fuses or circuit breakers prevent too much current from being drawn into the circuit.

3.311 Wires in house can only carry a certain amount of current.

3.312 Too much current will cause the wires to overheat and fire may result.

3.32 Current can be supplied from the panel in two voltages.

3.321 120 volts for general lighting and appliances.

3.322 240 volts for heavier equipment such as stoves or driers.

4. Assignment - Construct a diagram of the transmission of electric power from the generator to an appliance in the home.

LESSON 23 - D.C. Motors

1. Discuss circuit diagrams assigned in Lesson 22.

2. Review force exerted on a current carrying conductor which was developed in Lesson 16.

3. Use a simple St. Louis motor to illustrate the action of a simple d.c. motor.
   - 3.1 Use permanent magnets for the field.
   - 3.2 Show importance of position of brushes and commutator for maximum motion.

4. Back emf in a motor.
   - 4.1 Since the armature is a rotating conductor in a magnetic field it will have an emf induced in it.
   - 4.2 From Lenz's law this emf must be such as to oppose the cause of the induction so it will be in opposition to the voltage applied to the motor.
   - 4.3 Motor running at full speed with no load on it.
     - 4.31 Back emf will nearly equal the voltage applied to the motor.
     - 4.32 There will be very little current in the motor.
   - 4.4 Motor at less than full speed.
     - 4.41 Back emf will be less than at full speed.
     - 4.42 Voltage difference between the applied voltage and back emf will be higher.
     - 4.43 More current will flow through the armature.
   - 4.5 Motor with armature at rest.
     - 4.51 No back emf developed.
     - 4.52 Current in the armature will be very high.
   - 4.6 Starting circuit for a d.c. motor
     - 4.61 A large motor has considerable inertia in its rotor.
     - 4.62 It will take time to have it build up speed to the point where the back emf will keep the current at a safe level.
     - 4.63 The high current which might be drawn in starting the motor could cause the armature windings to burn out.
     - 4.64 Because of this a variable resistance is connected into the supply circuit and is gradually cut out as the motor gains speed and develops the back emf.

5. Types of d.c. motors
   - 5.1 Permanent magnet types
     - 5.11 Most of the small inexpensive battery operated motors in toys.
     - 5.12 Use a small permanent magnet to develop the magnetic field around the armature.

5.2 Electromagnet types
5.21 Use a field coil or coils to develope the magnetic fields around the armature.
5.22 There are three basic types
5.221 Series, shunt and compound
5.222 The connections are the same as for the d.c. generators discussed in Lesson 20.

6. Assignment - Develop circuit diagrams for the three types of d.c. motors and include a starting circuit for each.

LESSON 24 - A.C. Motors

1. Discuss diagrams from homework assignment.

2. Advantages of an a.c. motor
2.1 Fewer operating parts
2.2 Well adapted for constant speed applications
2.3 Maybe operated on single phase or poly-phase current sources.

3. The universal a.c. motor
3.1 Similar in construction to a small series wound d.c. motor.
3.2 Field cores are laminated.
3.3 Windings of the field and armature coils are designed to have minimum inductance.
3.4 Generally used in household appliances.
3.5 Sometimes used in industrial applications because of high starting torque.
3.6 Speed regulation is rather poor.

4. The induction motor
4.1 Most widely used type of a.c. motor.
4.2 Very rugged but with simple design.
4.3 Two basic parts
4.31 Stator of field coils.
4.32 Rotor
4.321 A laminated iron armature
4.322 Copper or aluminum bars inserted into the armature and shorted out by a ring at either end.
4.323 Conductors form a cylindrical cage often referred to as a "squirrel cage".

4.4 Single phase induction motor
4.41 The pulsating currents in the stator coils induce a current in the armature.

- 4.42 The polarity of the field established in the armature is opposite that in the stator field.
- 4.43 Under these conditions the armature will not turn.
- 4.44 Once the armature is started it will continue to run.
- 4.45 A second set of windings is employed to cause a rotation of the field to get the motor started.
- 4.46 Once in motion the starting windings are cut out of the circuit as they are no longer needed.

4.5 Three phase induction motor
- 4.51 Three sets of stator windings are applied at angles of 120° to each other.
- 4.52 When three phase power is applied to the stator a rotating magnetic field is developed.
- 4.53 These fields establish similar fields in the rotor and it will rotate with the fields.
- 4.54 The rotor has the tendency to follow the field.
  - 4.541 It cannot keep up with the field or there would be no induction.
  - 4.542 The actual speed of the rotor is thus less than speed of the rotating field. (Referred to as slip.)
- 4.55 Once started a poly-phase motor will operate on single phase current but like a single phase motor will not be able to start on single phase current.

5. Synchronous motors
- 5.1 Speed of motor is independent of the load within the capacity of the motor.
- 5.2 Speed is determined by the frequency of the alternating current applied to the motor.
- 5.3 Basic operation is similar to that of the single phase induction motor.
- 5.4 Widely used in electric clocks and timing mechanisms.

6. Assignment - Study for test on power distribution and motors.

Laboratory Experiments for Unit 3

At this point in the development of the student it is felt that exposure to commercially written laboratory activities is a desirable experience. For certain topics in this unit laboratory exercises will be utilized from Physics Workbook by Dull, Metcalfe and Williams, 1960 edition. Experiments written for specific apparatus by the manufacturer will also be utilized.

Experiment	
#15	Physics Workbook Experiment #53 - Magnetic Field About a Magnet.
#16	Physics Workbook Experiment #54 - Magnetic Field About a Conductor.
#17	Physics Workbook Experiment #55 - The Electromagnet
#19	Physics Workbook Experiment #47 - Measurement of Resistance - Voltmeter-Ammeter Method
#22	Physics Workbook Experiment #56 - Galvanometer Constants
#23	Physics Workbook Experiment #45 - Electrochemical Cells
#24 & #25	Electromagnetic Induction written by Central Scientific Company for the Gilley Induction Set.
#26	Physics Workbook Experiment #58 - Electric Motor

Name ______________________________ Date submitted ____________

Experiment #18 - OHM'S LAW

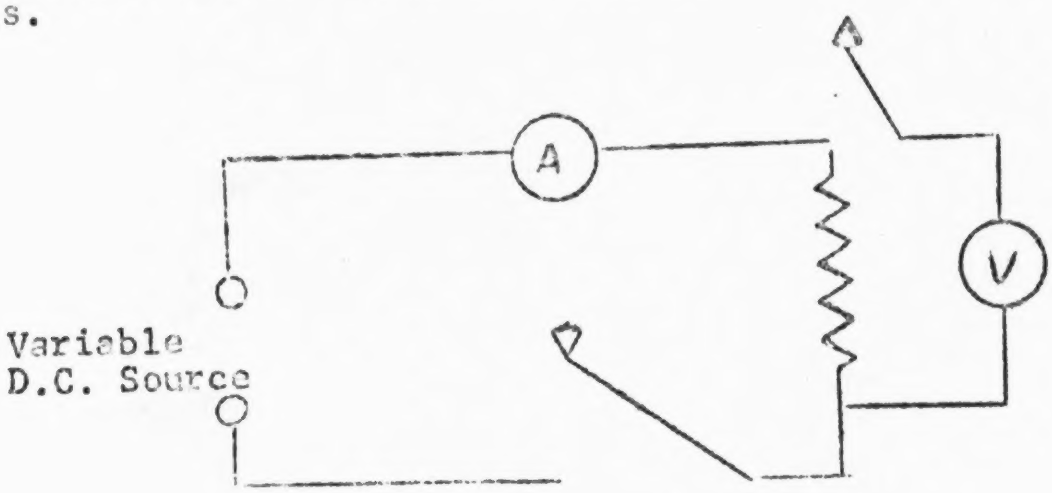
Purpose of experiment

1. To study the relationship between the voltage applied to a conductor and the current through the conductor.

Apparatus

Variable d.c. power supply, voltmeter, ammeter, four wire wound resistors, two spst switches and wire for making connections.

Diagram



Procedure

Set up the apparatus as shown in the diagram. For each conductor four trials will be made by varying the amount of voltage supplied to the circuit.

The voltage and current for each trial is recorded and the voltage to current ratio calculated.

A graph is made for each trial with the current values plotted on the x-axis and the voltages on the y-axis.

Data: - next page.

Questions:

1. What is the shape of the graphs______________________________

____

2. How do the V-I ratios for each conductor compare with each other?______________________________

____

3. From the answer to #1 and #2 what conclusion may be drawn concerning the relationship between the voltage applied to the conductor and the current through the conductor?__________

____

____

____

Trial		Voltage (volts)	Current (amp)	V/I
Conductor #1	1			
	2			
	3			
	4			
Conductor #2	1			
	2			
	3			
	4			
Conductor #3	1			
	2			
	3			
	4			
Conductor #4	1			
	2			
	3			
	4			

Name_________________________ Table__________ Date______

Partner________________________ Instructor's Approval__________

EXPERIMENT #18 - OHM'S LAW - ORIGINAL DATA SHEET

Data:

Trial		Voltage (volts)	Current (amp)	V/I
Conductor #1	1			
	2			
	3			
	4			
Conductor #2	1			
	2			
	3			
	4			
Conductor #3	1			
	2			
	3			
	4			
Conductor #4	1			
	2			
	3			
	4			

Name______________________________ Date submitted________________

Experiment #20 - SERIES AND PARALLEL CIRCUITS

Purpose of Experiment

To study the factor involved in series and parallel circuits.

To gain experience in using multimeters in electrical circuits.

Apparatus

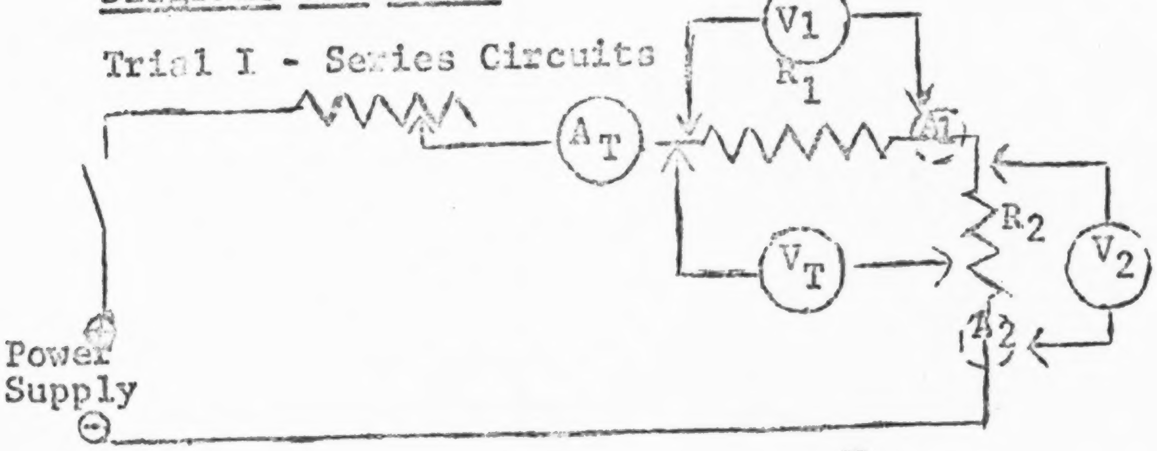
Variable d.c. power supply, vacuum tube voltmeter, volt-ohm-milliameter, three wire wound resistors, spst switch and wire for connections.

Procedure

Apparatus is set up as illustrated for each trial and the requested measurements are made. The vacuum tube voltmeter will be used for the voltage measurements and the proper range on the volt-ohm-milliameter will be used for the current readings.

Diagrams and Data:

Trial I - Series Circuits



I_T =_____ amp.

I_1 =_____ amp.

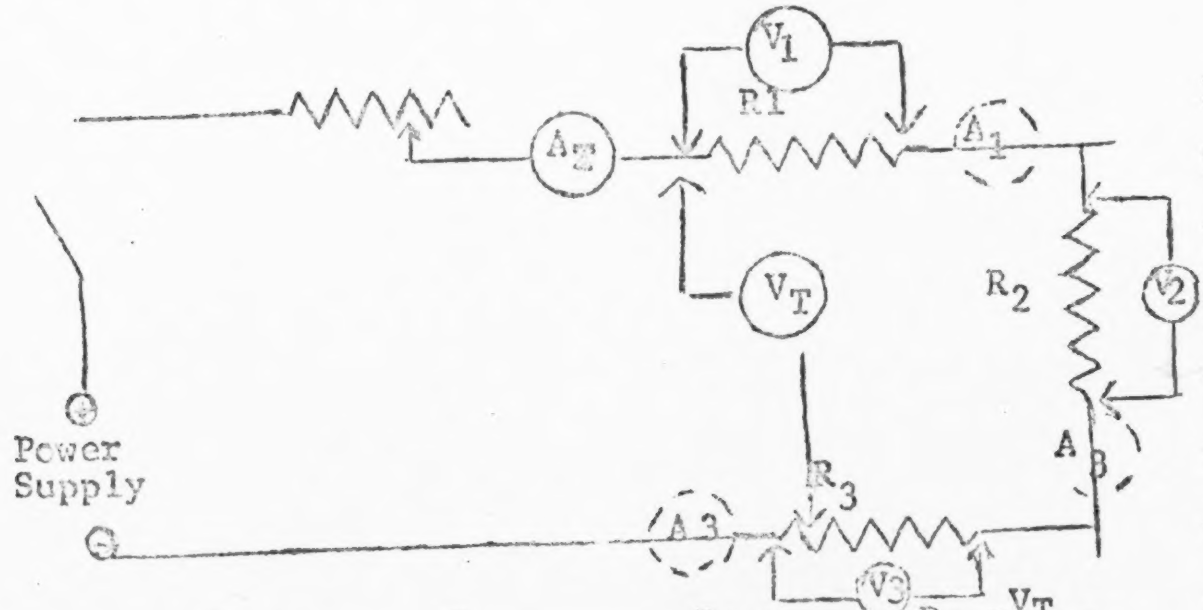
I_2 =_____ amp.

V_T =_____ v

V_1 =_____ v

V_2 =_____ v

R_1 = _____ R_2 = _____ $R_T = \frac{V_T}{I_T}$ = _____



I_T =_____ amp.

I_1 =_____ amp.

I_2 =_____ amp.

I_3 =_____ amp.

V_T =_____ v

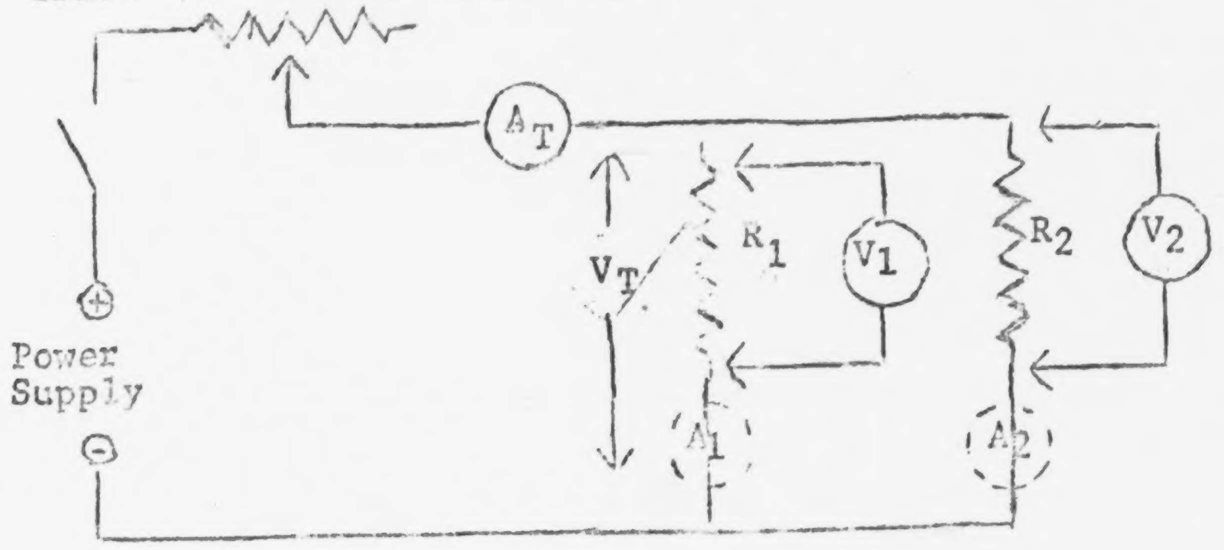
V_1 =_____ v

V_2 =_____ v

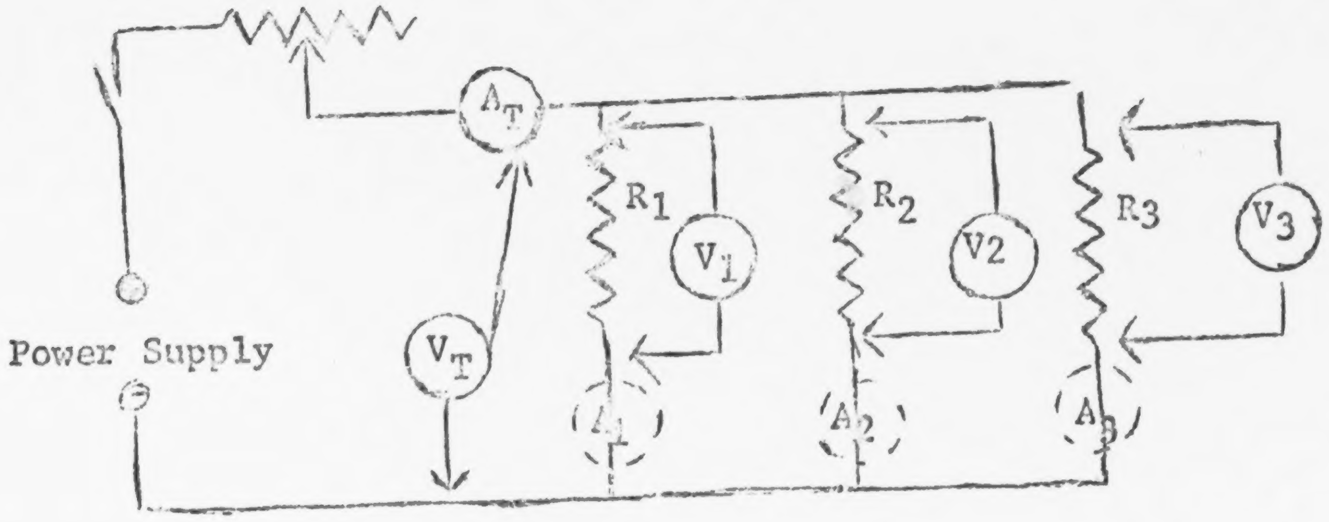
V_3 =_____ v

R_1 =_____ R_2 =_____ R_3 =_____ $R_T = \frac{V_T}{I_T}$ =_____

Trial 2 - Parallel Circuits



A_T
V_T
R_1
V_1
R_2
V_2
A_1
A_2
Power Supply



A_T
R_1
V_1
R_2
V_2
R_3
V_3
V_T
A_1
A_2
A_3
Power Supply

Questions:

Part 1 - Series Circuit

1. How does the total current compare with the current through each resistance?____

2. How does the total voltage compare with the voltages across the individual resistances?________________________________

3. How does the total resistance compare with the individual values?____

Part 2 - Parallel circuit

1. How does the total current compare with the current through each resistance?____

Industrial Prep Physics Projects

Projects for Industrial Prep Physics

The tests and testing devices are designed to acquaint the student with ways in which information can be obtained about these concepts and enable them to then understand what happens in industrial testing devices.

Experience will also be gained in careful planning of activities and comprehensive reporting of work and results.

These projects will lend themselves well to correlation with the areas of math, mechanical drawing, shops and English.

There will be ample opportunity for the growth and development of the applications of scientific methods to the solution of problems. Also a good deal of opportunity is provided for developing the use of measurement in scientific and practical applications.

The general nature of the projects is such as to require the student to improvise and also to devise ways in which to obtain the desired information and to determine that information which is pertinent and that which is not. We feel that this is one of the more important goals of the program.

Projects have been designed with some degree of complexity so that a team approach to the project can be utilized. Several students will have the responsibility to develop a part of the project and then will have to assemble and test as a group. This interdependency will give further insight into the individual's contribution to the whole of an industry.

Expected outcomes for the student

1. A working knowledge of the specific principals or properties which he is testing.
2. Skill in designing and developing procedures for testing.
3. A good understanding of the application of measuring.
4. Increased skill in observation and recording of observation.
5. An understanding of and ability to compose a good working report of an assigned scientific activity.

PROJECT - Bursting Strength Testing Device - Plunger Method

Objectives

1. To develop an understanding of the principle of testing bursting strength
2. To test the bursting strength of paper, plastic film and metal foils

Description

A one quarter inch diameter plunger (dowel) is forced through a sheet of material which is clamped between two wooden blocks. The amount of weight needed to do this is divided by the area of the plunger and recorded as the bursting strength of the sample.

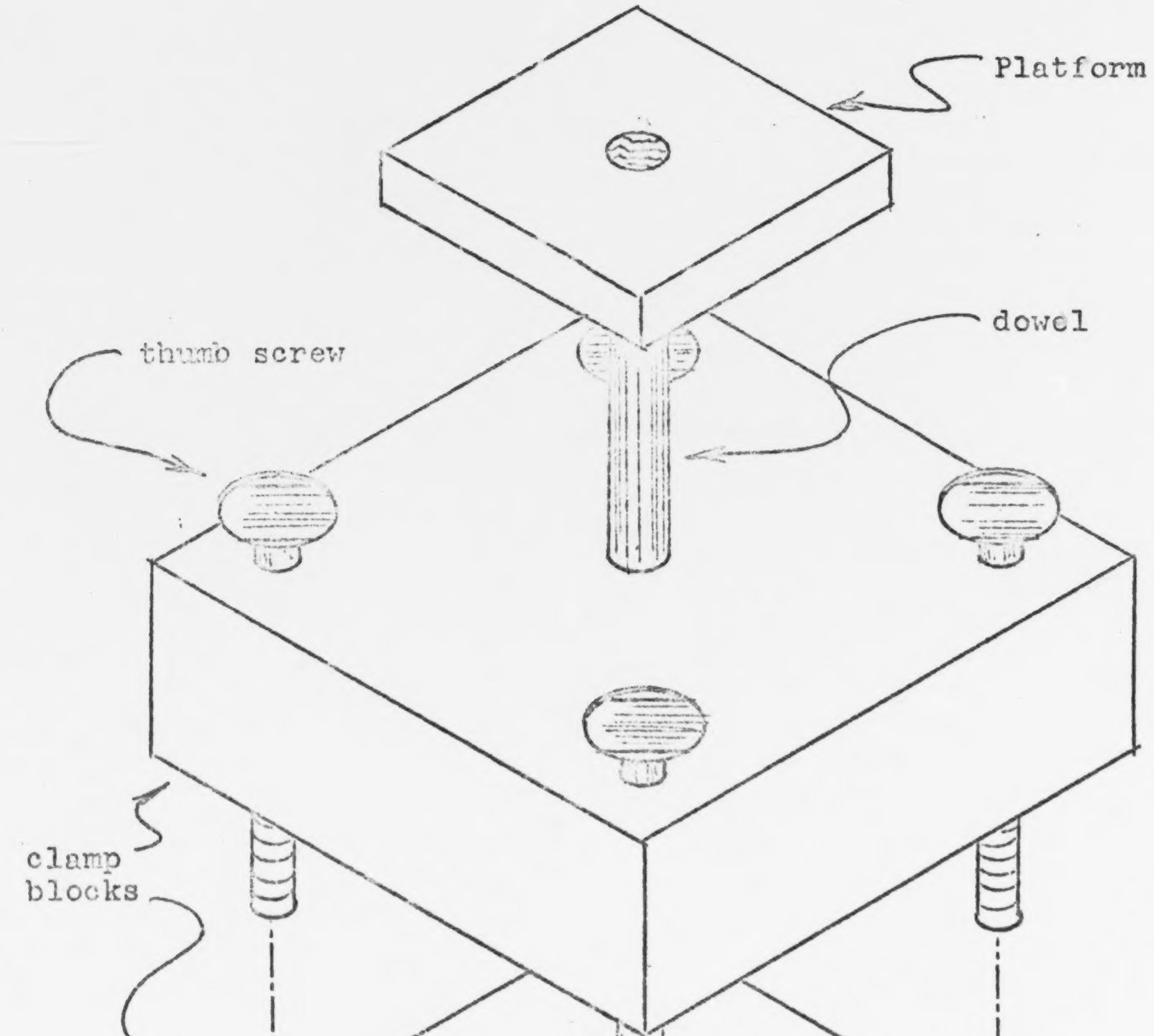
Materials

(standard)

4 - 1/4"-20 2" thumb screws
4 - 1/4"-20 tee nuts (wood)
4 - 1/4" steel / brass washers

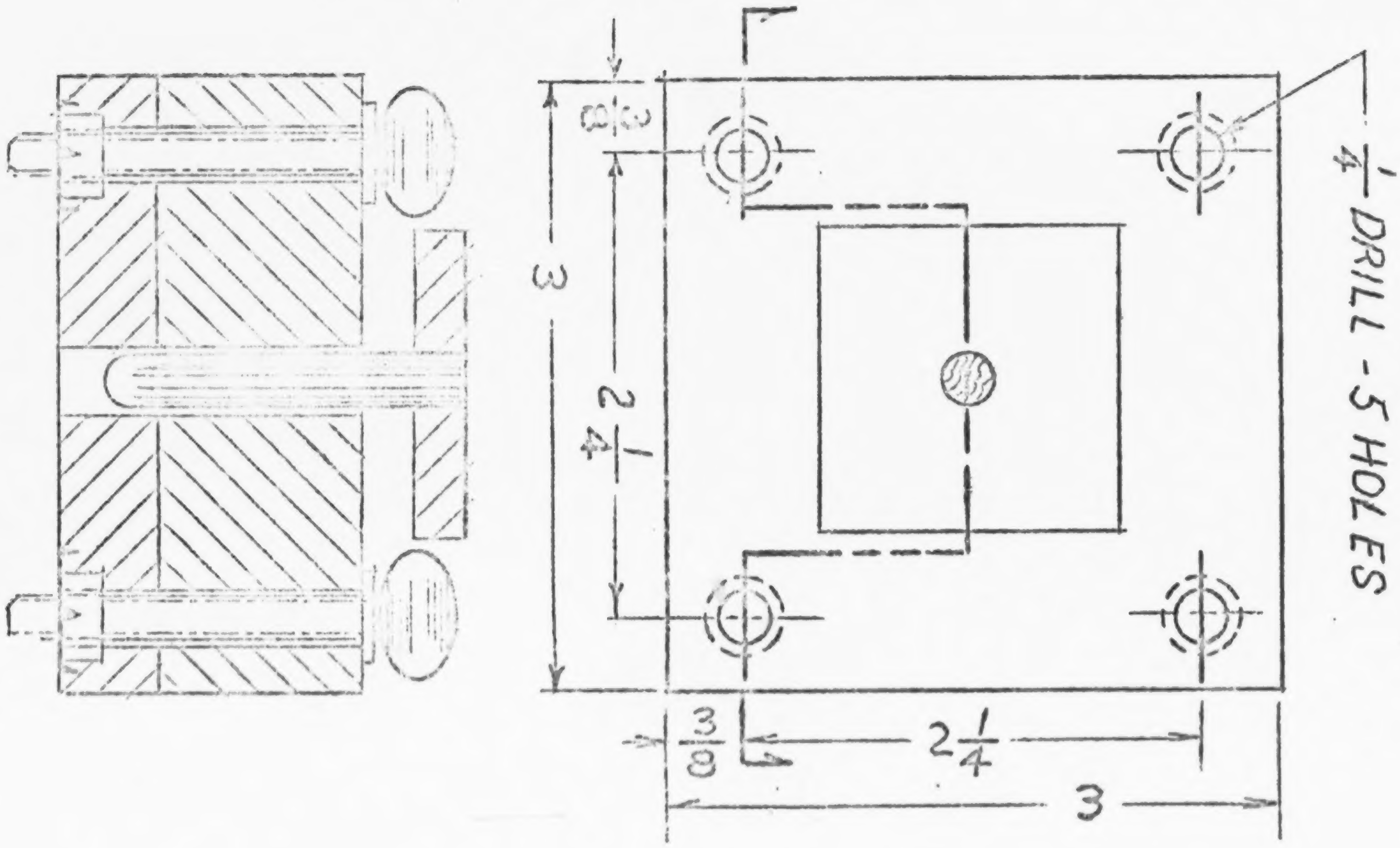
(other)

1 - upper clamp 3" x 3" x 1" hardwood
1 - lower clamp 3" x 3" x 1" hardwood
1 - platform 1/4" plywood 1 1/2" x 1 1/2"
1 - plunger 1/4" dowel x 1 3/4" long


Platform
dowel
thumb screw
clamp blocks
place sample here
tee nut (wood)

BURSTING TEST DEVICE

BURSTING TEST DEVICE


3/8
3
2 1/4
1/4 DRILL - 5 HOLES
3/8
2 1/4
3

PROJECT - Hardness of Metals - Rockwell Type Testing

Objectives

1. Develop an understanding of the nature of the Rockwell Hardness Test.
2. To test the hardness of various types of metals found in the metal shop
3. Devise a hardness scale for the metals tested

Description and Procedure

The Rockwell Test involves the degree of impression a hardened steel ball will make in the surface of a metal plate under a fixed amount of pressure.

The apparatus consists of two square metal plates spaced one half inch apart by two narrow rectangular spacer bars which are secured in position by nuts and bolts. The upper plate is tapped to receive a one half inch bolt. The threaded end of the bolt is counterdrilled to receive a ball bearing and a length of drill rod with a diamond point ground on the tip that protrudes and makes the impression in the samples.

When testing, this device is clamped in a metal vise- (vise jaws engage the lower plate). A metal sample is placed in between the plates and the bolt is tightened down onto the block with a torque wrench to a selected amount of force (torque). The bolt is then loosened, and the sample removed - the diameter of the impression made by the diamond point is measured with a microscope equiped with a measuring reticle. Various metals are so tested and the diameters of the impressions recorded. From these diameters a hardness scale can be devised

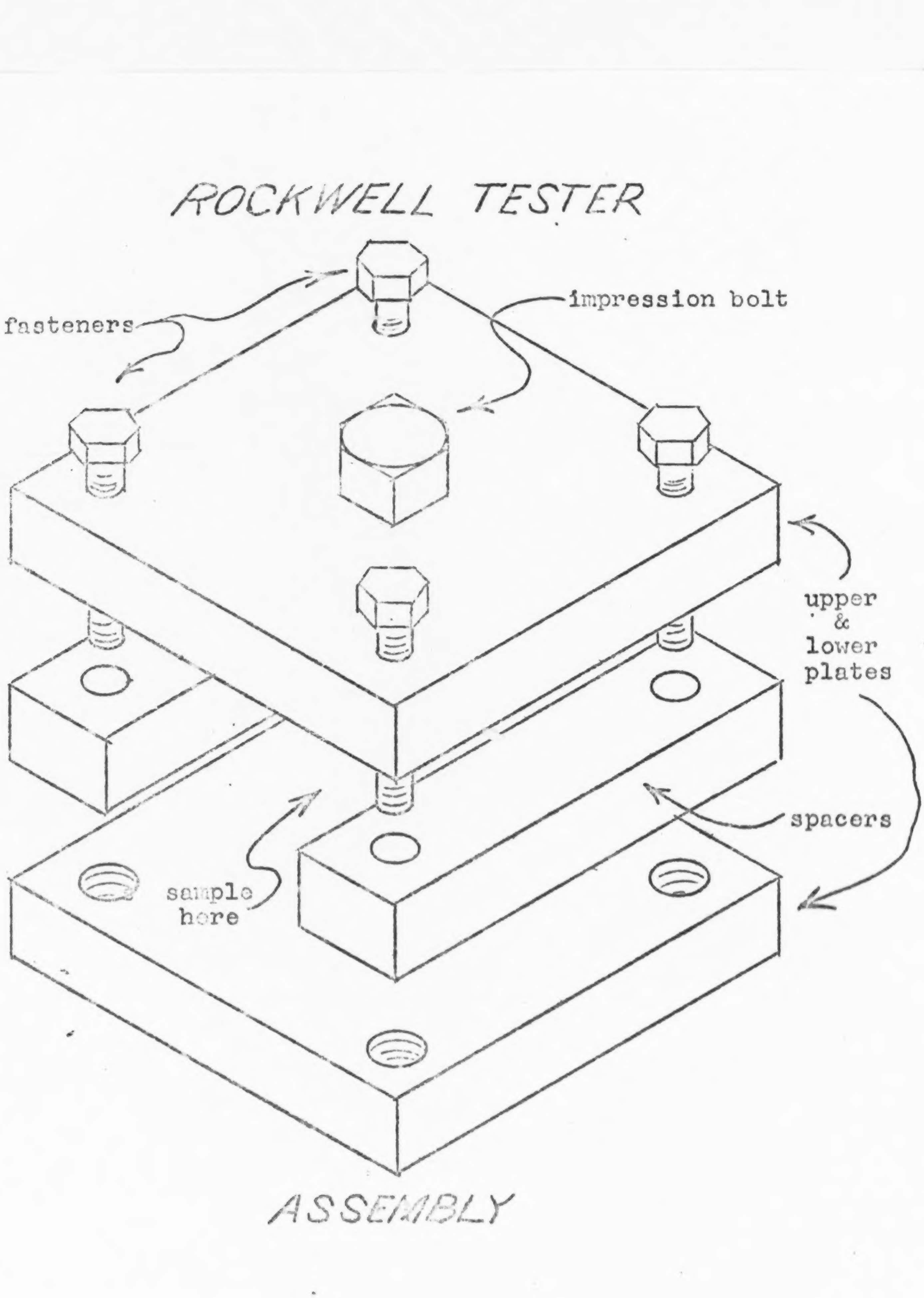
Materials

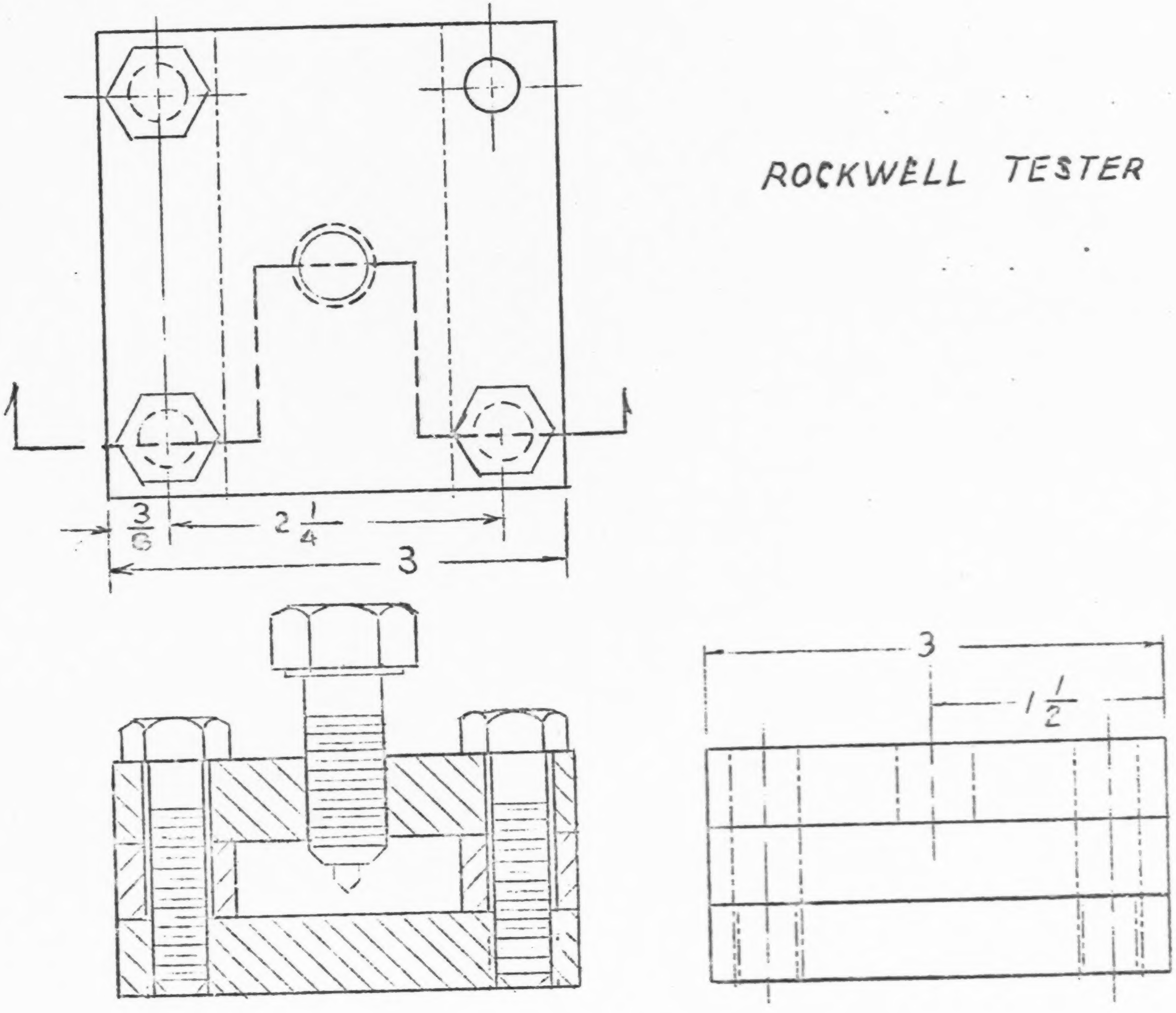
(standard)

1 - 1/2"-13 x 1 1/2" Amer. Std. hex bolt
4 - 3/8"-16 x 1 1/2" Amer. Std. hex bolt
4 - 3/8" washers
1 - 1/2" washer
1 - 1/8"Ø x 3/4" long drill rod

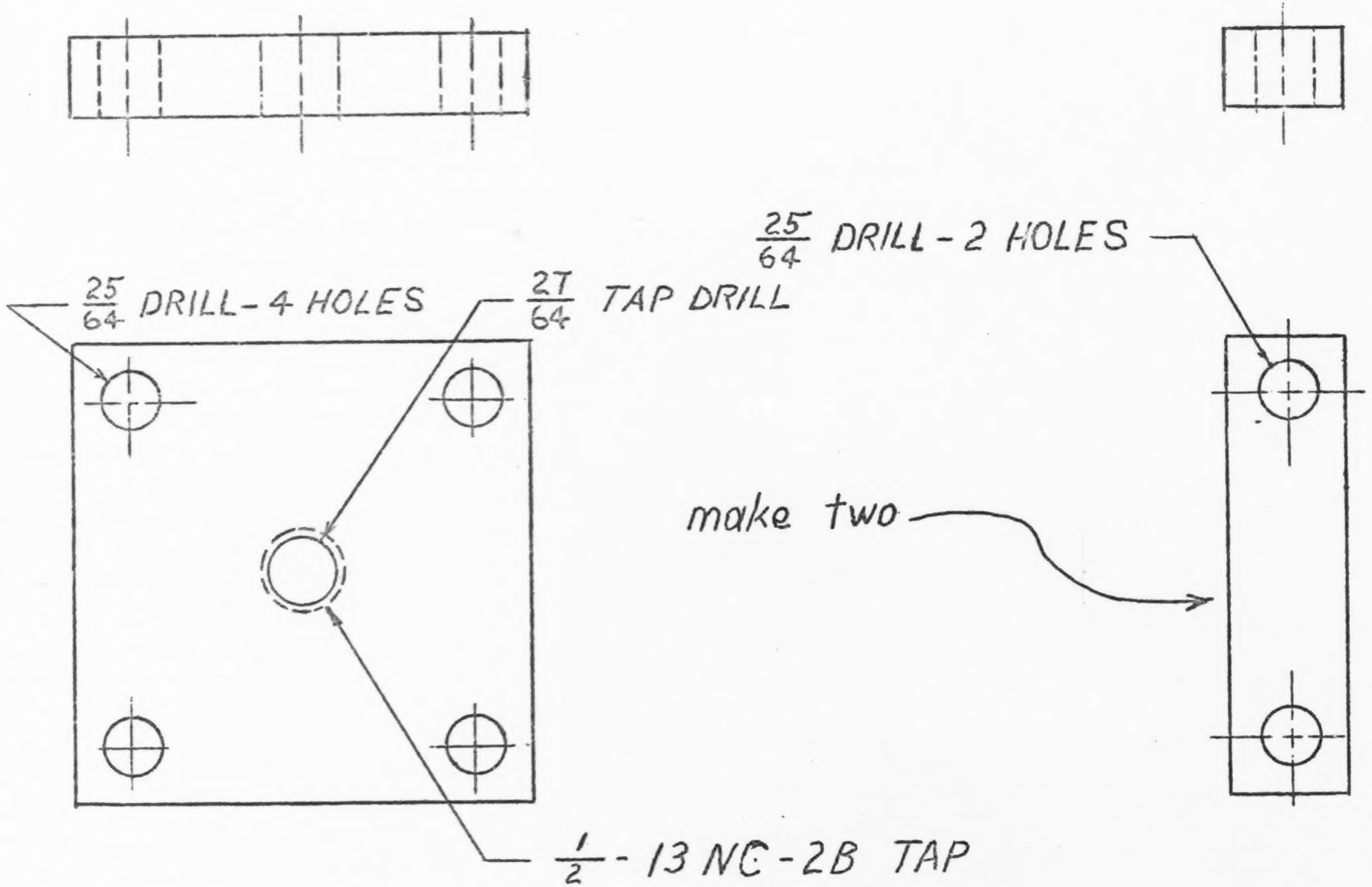
(other)

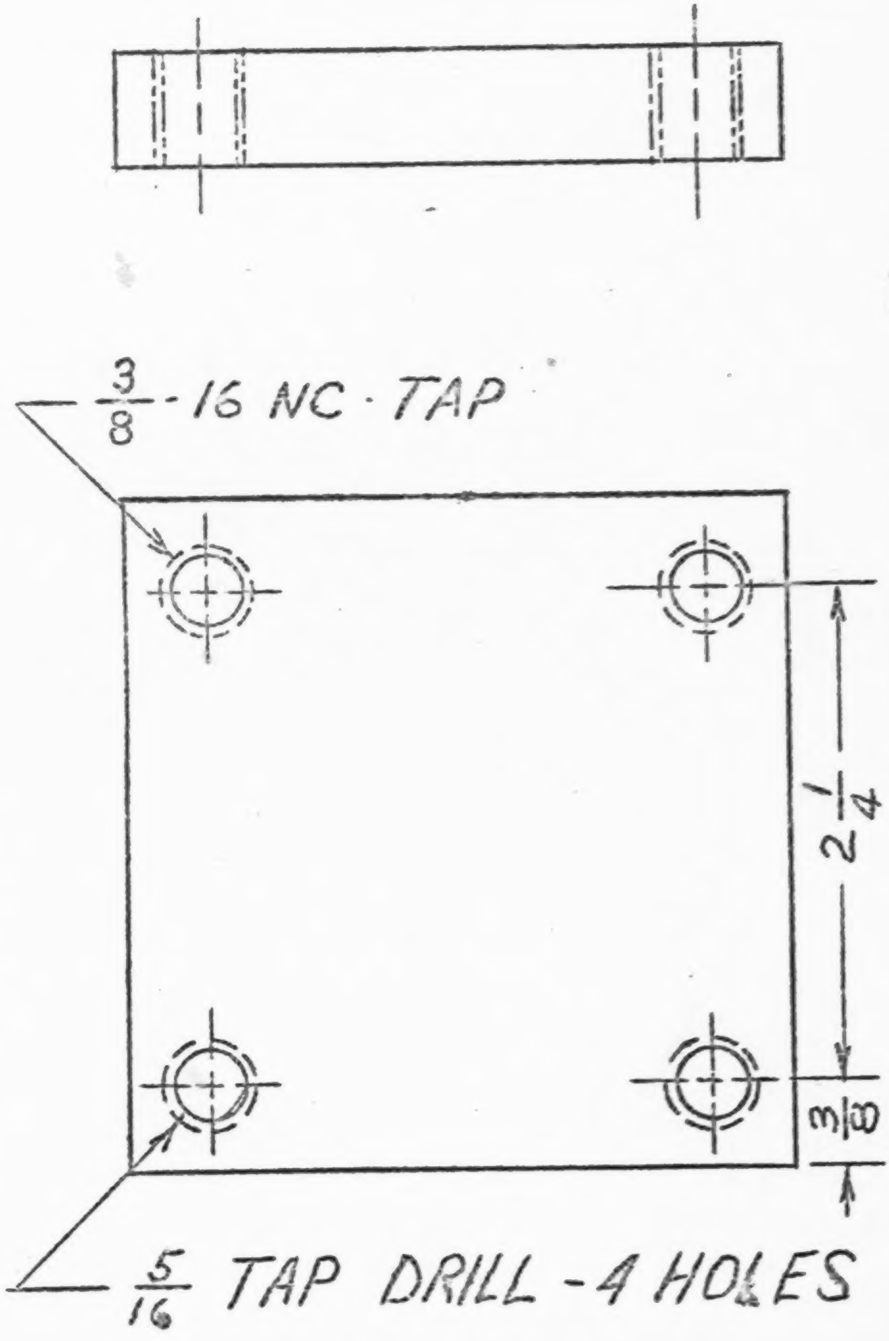
2 - steel plates 3" x 3" x 1/2"
2 - spacer blocks 3" x 3/4" x 1/2" steel / alum stock

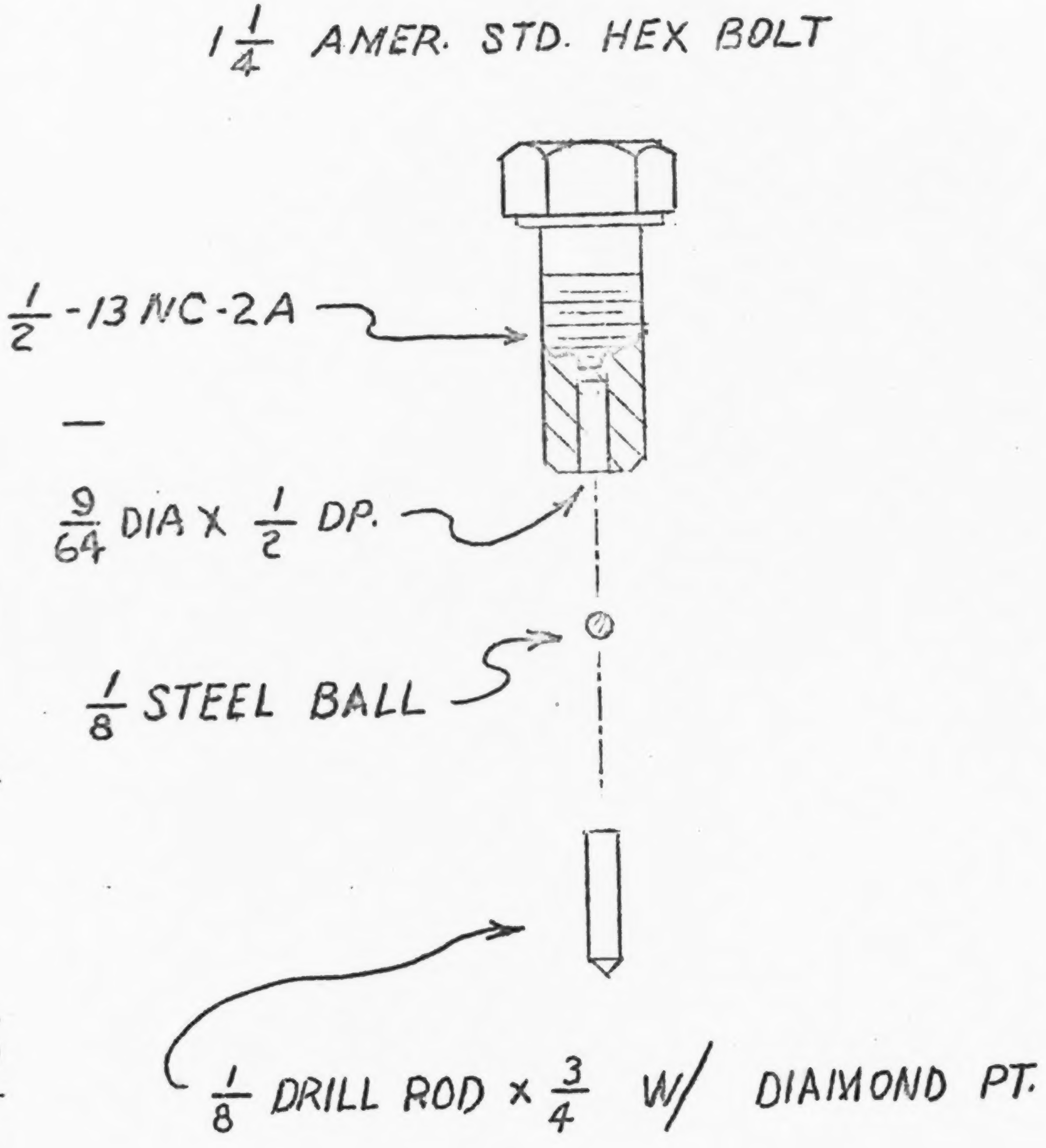

ROCKWELL TESTER
fasteners
impression bolt
upper & lower plates
spacers
sample here
ASSEMBLY


3/8
2 1/4
3
3
1 1/2

ROCKWELL TESTER


$\frac{25}{64}$ DRILL - 4 HOLES
$\frac{27}{64}$ TAP DRILL
$\frac{1}{2}$ - 13 NC - 2B TAP
$\frac{25}{64}$ DRILL - 2 HOLES
make two


$\frac{3}{8}$-16 NC · TAP
$2\frac{1}{4}$
$\frac{3}{8}$
$\frac{5}{16}$ TAP DRILL - 4 HOLES


$1\frac{1}{4}$ AMER. STD. HEX BOLT
$\frac{1}{2}$-13 NC-2A
$\frac{9}{64}$ DIA X $\frac{1}{2}$ DP.
$\frac{1}{8}$ STEEL BALL
$\frac{1}{8}$ DRILL ROD × $\frac{3}{4}$ W/ DIAMOND PT.

PROJECT - Hardness of metal - Shore Sclerscope Type Testing

Objectives

1. Develop an understanding of the nature of the Shore Scleroscope Hardness Test.
2. To test the hardness of various types of metal found in the metal shop
3. Devise a hardness scale for the metal tested

Description and Procedure

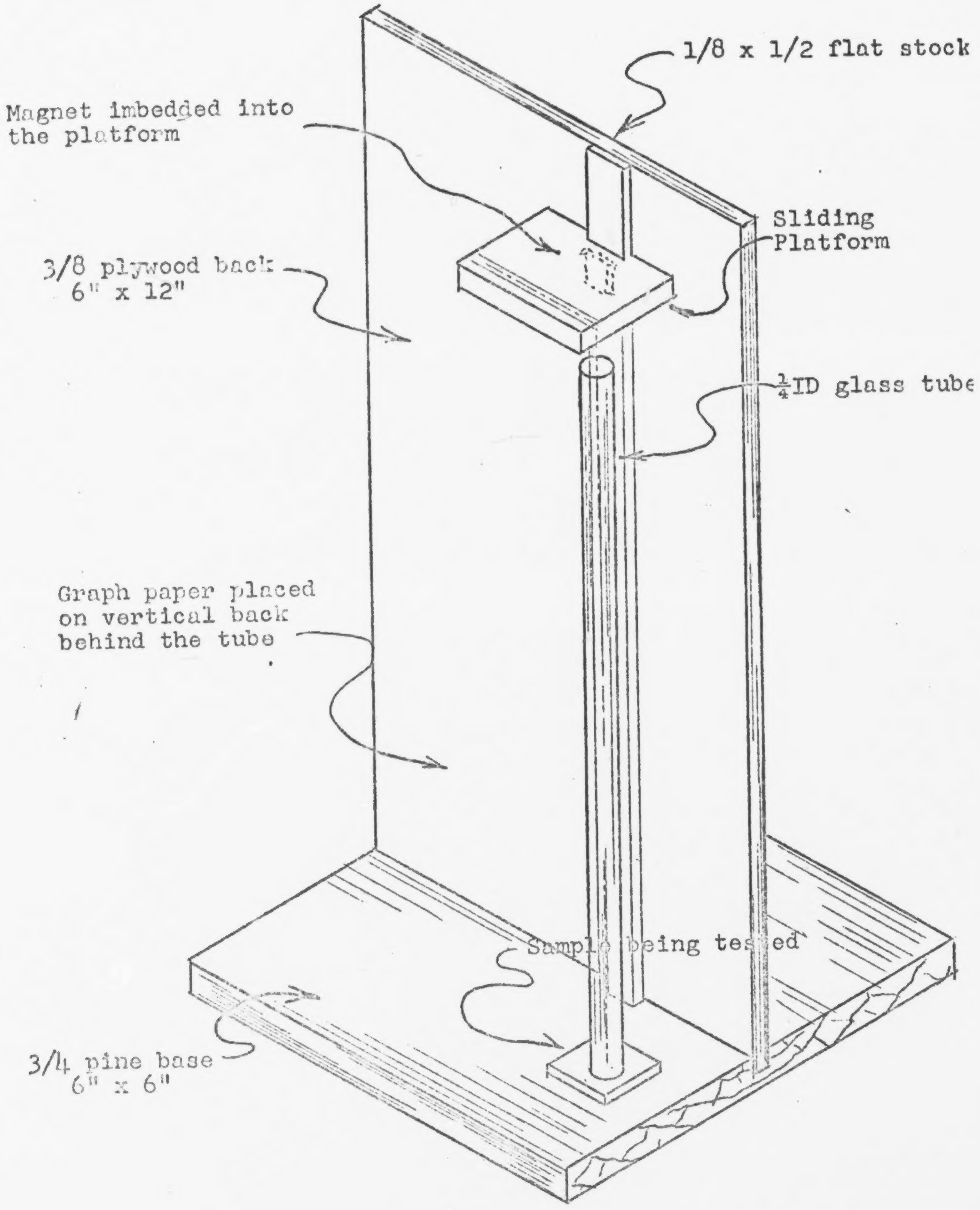
The Shore Scleroscope Test involves the height to which a small ball will bounce off the surface being tested.

The apparatus consists of a base upon which the sample will be placed, behind the drop area is fastened a sheet of graph paper to indicate the height of the bounce and a small grooved platform from which to release the ball

Several drops are made on the surface of the sample and the height of the bounce recorded for each trial. The average height is then determined and this can be compared with results from other samples

Materials

1 - base 6" x 6" 3/4" pine
1 - vertical plate 3/8" plywood 6" x 12"
4 - 1/4" ID glass tubes, assorted lengths
1 - platform 1 1/4" x 1 1/4" x 1/2" wood / support angle
1 - graph paper
4 - paper clips
1 - 1/8" ball bearing
4 - 1" x 1" samples
1 - 11" length of flat stock 1/8" x 1/2" steel
1 - Alnico magnet, small
4-- 1/2" # 4 FH wood screws


1/8 x 1/2 flat stock
Magnet imbedded into the platform
Sliding Platform
3/8 plywood back 6" x 12"
¼ID glass tube
Graph paper placed on vertical back behind the tube
Sample being tested
3/4 pine base 6" x 6"

SHORE SCLEROSCOPE TYPE TESTING
Hardness

PROJECT - Shear Strength Testing Device

Objectives:

1. To develop an understanding of one process of shear testing
2. To test the shear strength of various samples of woods and plastics

Description

A five pound brass pendulum is released and allowed to swing down and strike the sample which is clamped at the base of the pendulum's swing. The measure of the shear strength will be recorded by the height to which the pendulum swings after shearing the sample

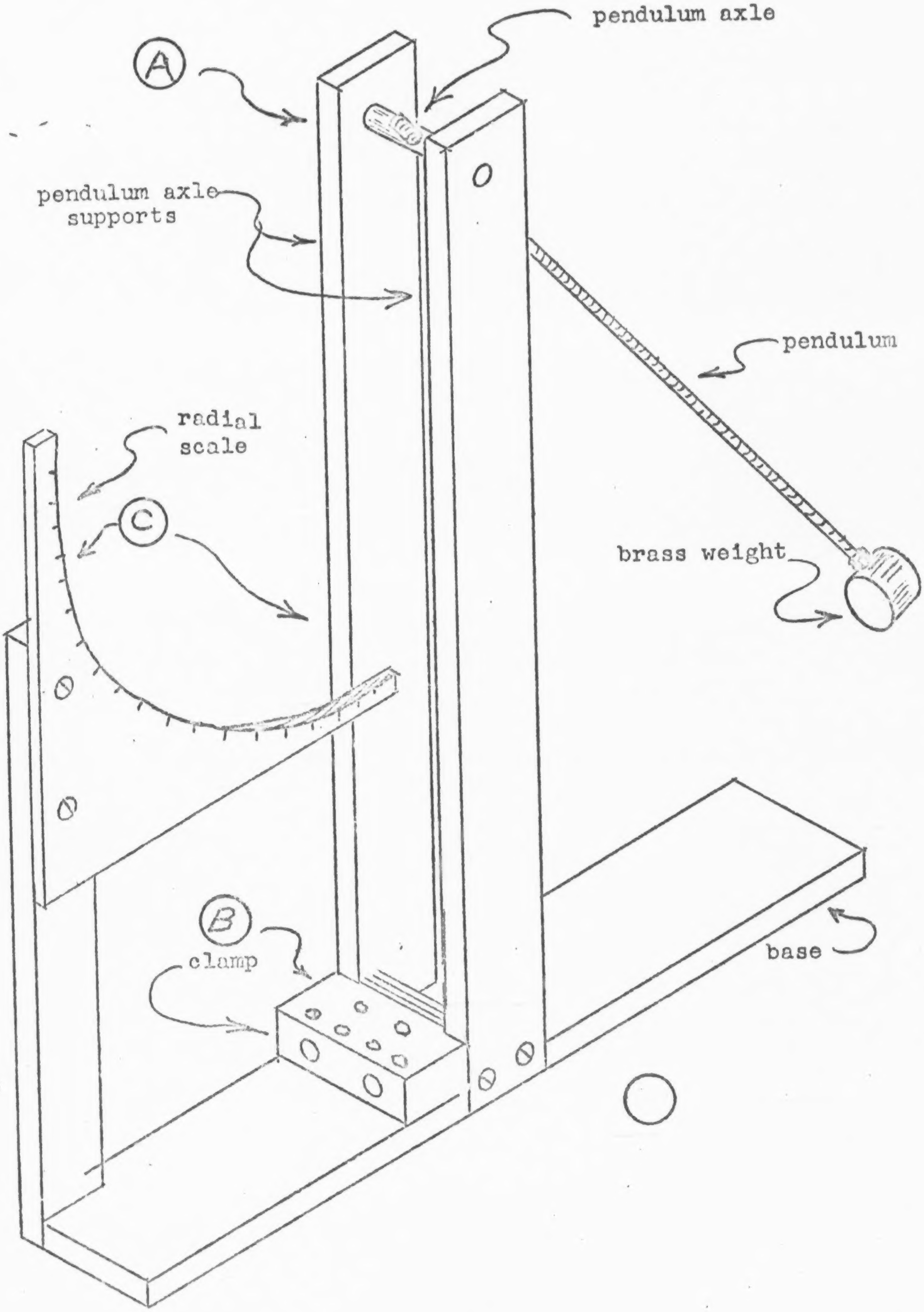
Materials

(standard hardware)

2 - 3/8"-16 x 4 1/2" shouldered thumb screws
2 - 3/8"-16 thumb nuts
1 - 3/8"-16 x 36" threaded stock
2 - 3/8"-16 American standard hex nuts
6 - 3/8" steel / brass washers
2 - 3/8" spring lock washers
4 - 3/8"-16 x 3 1/2" FH machine screws
4 - 3/8"-16 Tee nuts (wood)
3 - #10-3/4" FH wood screws
6 - #10-1 1/2" FH wood screws

(Other materials)

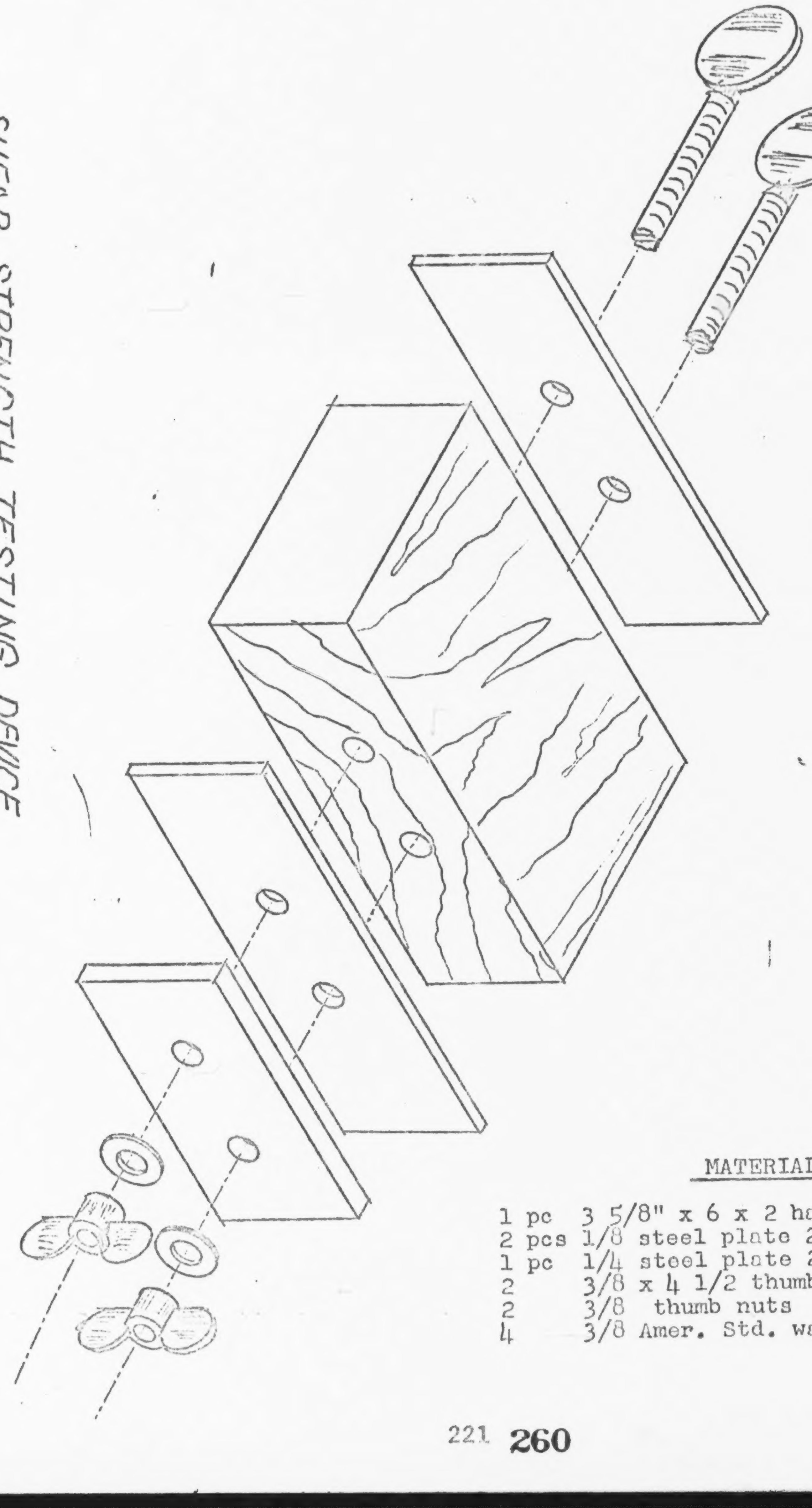
1 - clamp body 3 5/8" x 6" x 2" hardwood
2 - clamp faces 1/8" steel plate 2" x 6"
1 - Forward clamp face 1/4" steel plate 2" x 4"
1 - pendulum weight 3"℄ brass x 2 3/8"
1 - pendulum axle 3/4" ℄ aluminum x 6"
1 - radial scale 1/4" plywood 18" x 18"
1 - radial scale support 30 1/8" x 2" x 1" pine
1 - base 36" x 6" x 5/4" hardwood
2 - axle supports 40 1/8" x 3" x 1" hardwood


pendulum axle
A
pendulum axle supports
pendulum
radial scale
C
brass weight
B
clamp
base

SHEAR STRENGTH TESTING DEVICE

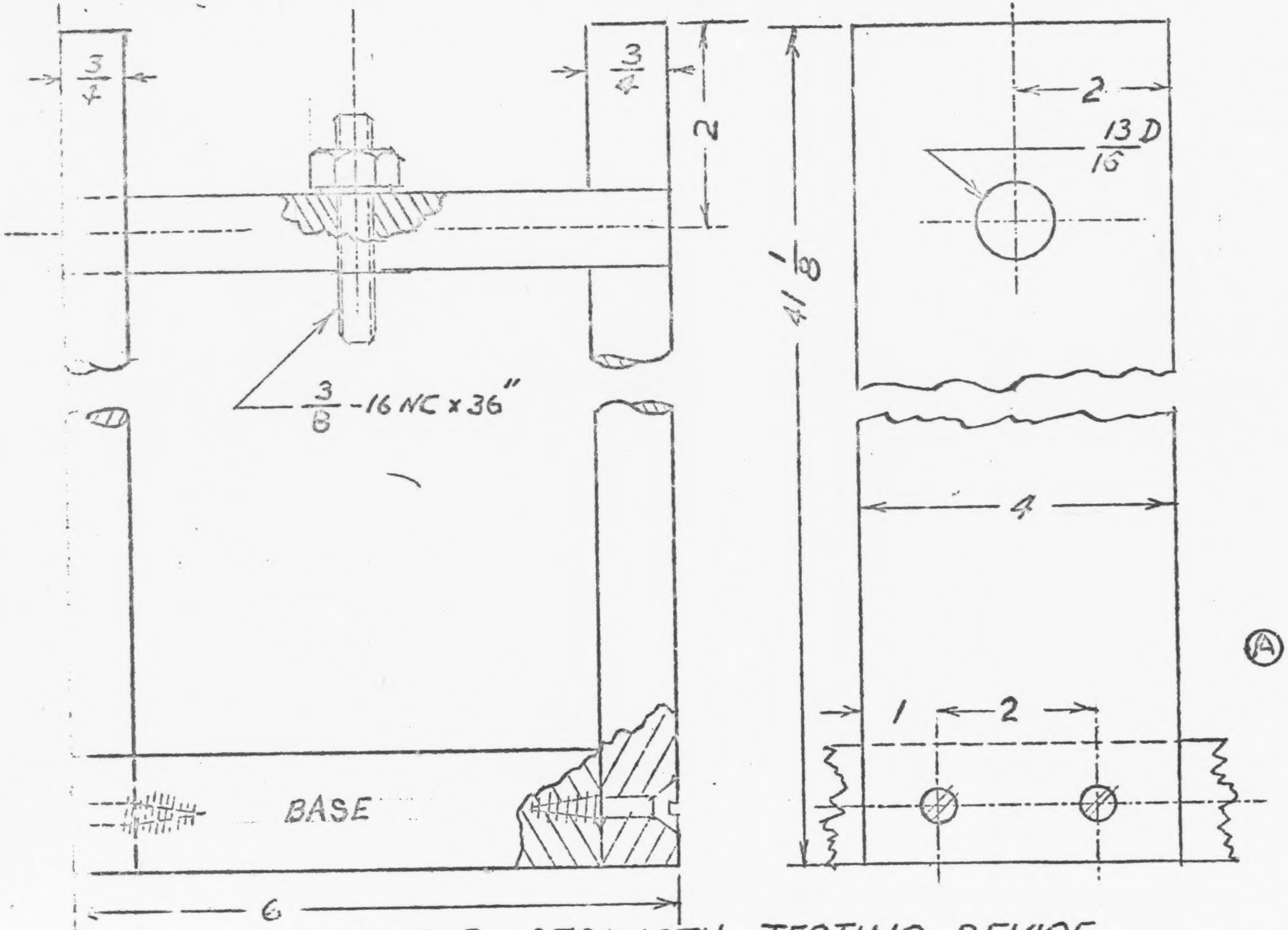
SHEAR STRENGTH TESTING DEVICE

CLAMP (B)



MATERIALS

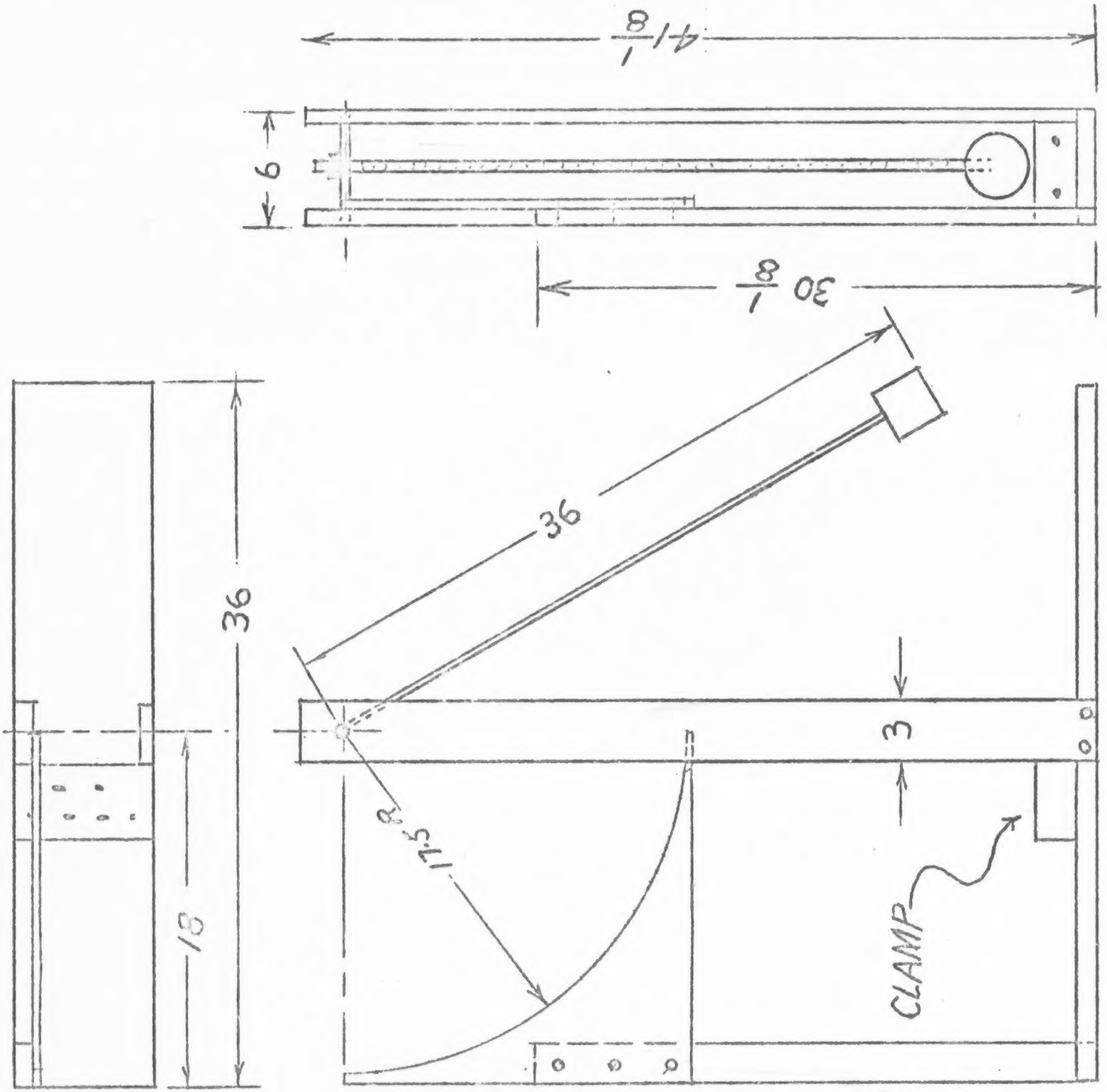
1 pc 3 5/8" x 6 x 2 hardwood
2 pcs 1/8 steel plate 2" x 6"
1 pc 1/4 steel plate 2" x 4"
2 3/8 x 4 1/2 thumb screws
2 3/8 thumb nuts
4 3/8 Amer. Std. washers


3/4
3/4
2
3/8 -16 NC x 36"
BASE
6
41 1/8
2
13 D/16
4
Ⓐ
1
2

SHEAR STRENGTH TESTING DEVICE

SHEAR STRENGTH TESTING DEVICE ©

H.F.


41 1/8
6
30 1/8
36
36
3
17.5 R
18
CLAMP
18
21 1/8
39 1/8

PROJECT - Tensils strength of materials

Objectives

1. Develop an understanding of the nature of tensile strength testing
2. Test the tensile strength of various types of paper, plastic films and metal foils

Description and procedure

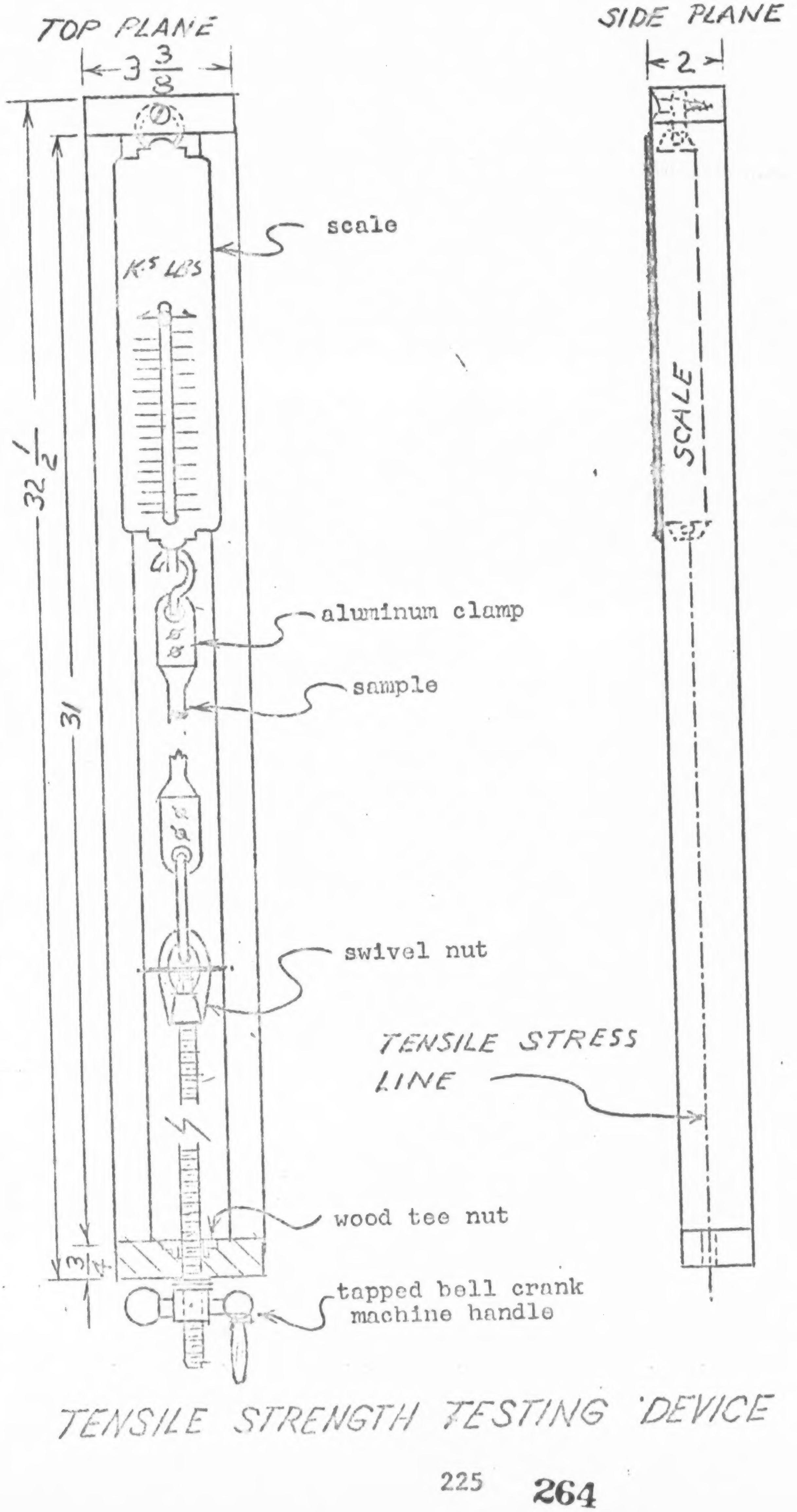
Two clamps to hold the opposite ends of the test sample are needed. One clamp is fixed to the hoozontal supporting frame. The clamp at the other end has a hole into which the spring scale is located. A threaded axle mounted in the frame draws the scale away from the opposite side thereby placing a tensile stress on the sample material. The force required to break the material is recored on the scale via a sliding magnet. The tensile strength of the sample is found by dividing the cross sectional area of the sample into the force needed to break the sample

Materials - (standard)

Quantity		Description
1.	3/8-16	bell crank machine handle
1.	3/8-16	steel swivel eye nut / steel eye nut
2.	3/8-16	American standard hex nut
5.	3/8	American standard steel / brass washers
1.	3/8-16	x 8" steel stock
4.	3/16-24	x 1/2 collar screws
4.	3/16-24	wing nuts
4.	3/16	washers
1.	1 3/4	#10 F.H. wood screws

Materials - (other)

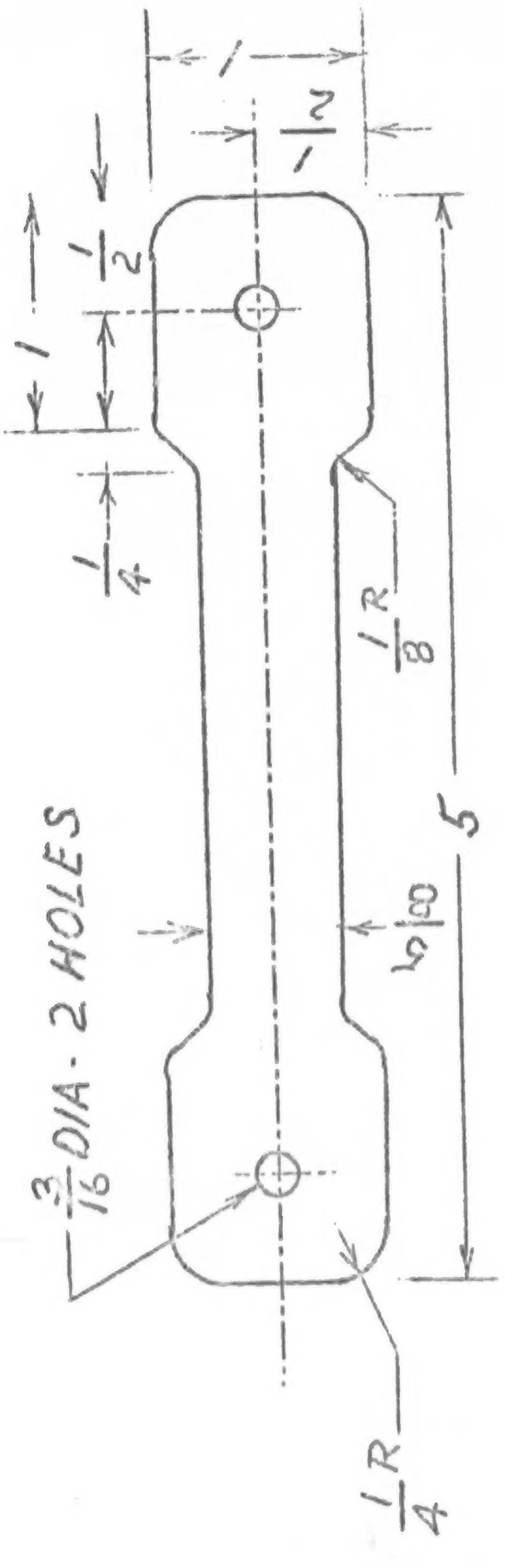
2. 3 3/8 x 2 x 3/4 hardwood
2. 31 x 2 x 3/4 hardwood
4. 1/8 aluminum plate 1 x 2
1. 1/8 ⌀ x 2 3/4 steel rod


TOP PLANE
3 3/8
32 1/2
31
3/4
K.S LBS
scale
aluminum clamp
sample
swivel nut
wood tee nut
tapped bell crank
machine handle
SIDE PLANE
2
SCALE
TENSILE STRESS
LINE

TENSILE STRENGTH TESTING DEVICE

TENSILE STRENGTH TESTING DEVICE

TEMPLATE OF SAMPLE


1
1/2
1/2
1
1/4
1/8 R
5
5/8
3/16 DIA · 2 HOLES
1/4 R

PROJECT - Electrical Conductivity of Liquids

Objectives

1. To measure the conductivity of various liquids
2. To develop an appreciation of the safety factors involved in working with electrical equipment

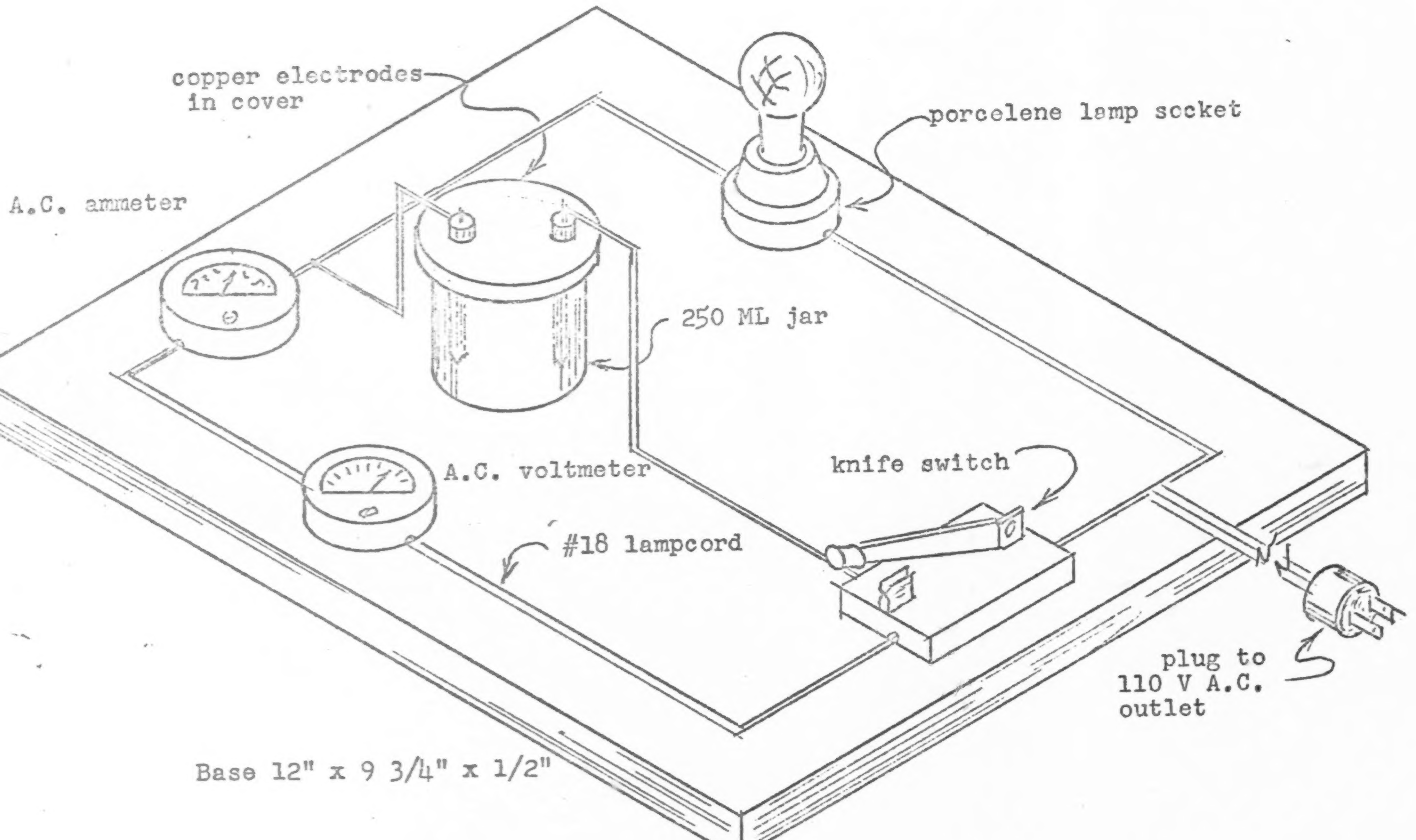
Description

The apparatus consists of a circuit board enabling the insertion of electrodes into various liquids and measuring the current flowing through the solution.

Various liquids are tested, noting the current through and voltage across the solution. A light bulb is also used to give additional visual indications of the reaction.

Materials

1 - base 12" x 9 3/4" x 1/2" wood. Plywood etc.
1 - standard porcelene lampsocket (surface mount)
1 - 60 watt bulb (clear)
1 - SPST knife switch
6 - binding posts
1 - 250 ML jar
1 - cover 1/8" masonite (exterior) 4" x 4"
2 - 1/8" dia. copper rod
1 - A.C. voltmeter
1 - A.C. ammeter
1 - A.C. male plug


copper electrodes in cover
porcelene lamp socket
A.C. ammeter
250 ML jar
A.C. voltmeter
knife switch
#18 lampcord
plug to 110 V A.C. outlet
Base 12" x 9 3/4" x 1/2"

ELECTRICAL CONDUCTIVITY OF LIQUIDS.

PROJECT - Fuse Load Capacity Apparatus

Objectives

1. Compare and contrast older conventional fuse boxes and the newer circuit breaker type boxes
2. There is a correlation between total ampere rating of the service and the number of circuits that may be provided therein. i.e. 100 amp. = 8 circuits.
3. When a circuit becomes overloaded. Why?
4. Safety factors

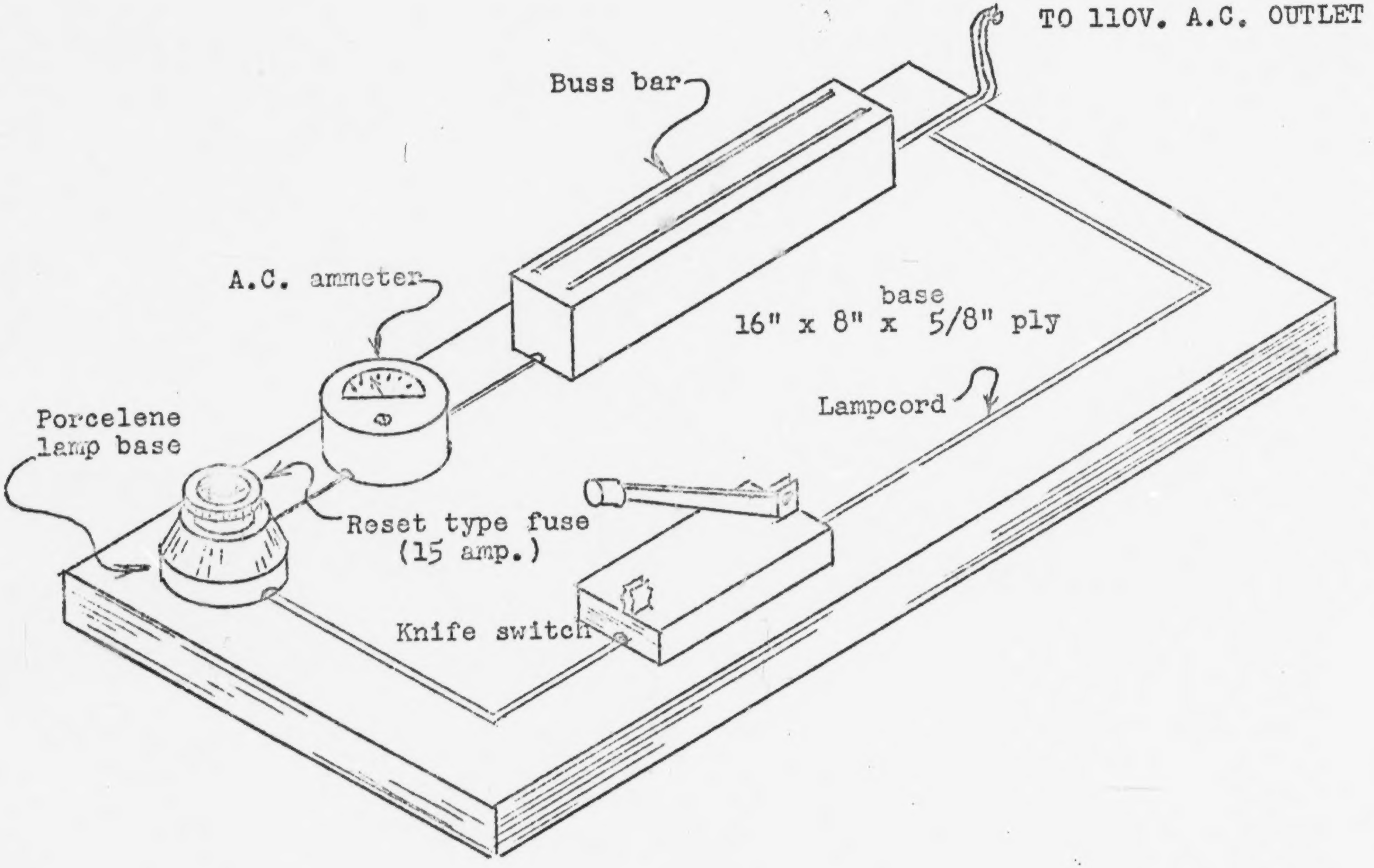
Description

The materials indicated for this project provide you with all the components of a simple circuit. The apparatusoonsists of a base board which mounts an electrical line (circuit). The following components are hooked up in series along this #18 lampcord line: buss bar(electrical outlet capable of receiving many plugs at one time), A.C. ammeter, porcelene lamp base with a reset type fuse and one knife switch. Upon introducing an appliance to the buss bar one can check amps. being drawn off the 15 amp. circuit and so on until the fuse blows. Check the results of a penny backed fuse on an overloaded fuse; be sure to follow the instructor's direction carefully and observe all safety procedures.

Materials

1 - 8" or 10" buss bar
1 - A.C. ammeter
1 - Porcelene lamp base (surface mount)
1 - 15 amp. reset type fuse
1 - 20 amp. reset type fuse
1 - 30 amp. reset type fuse
1 - knife switch
1 - four foot length of # 18 lamp cord
1 - base 5/8" plywood 16" x 8"

FUSE LOAD CAPACITY APPARATUS


TO 110V. A.C. OUTLET
Buss bar
A.C. ammeter
base
16" x 8" x 5/8" ply
Lampcord
Porcelene
lamp base
Reset type fuse
(15 amp.)
Knife switch

PROJECT - Insulating Value of Tapes

Objectives

1. To measure the insulating value (ability) of various types of tape
2. To develop an understanding of transformer operation
3. To develop an appreciation for safety precautions in working with high voltages

Description

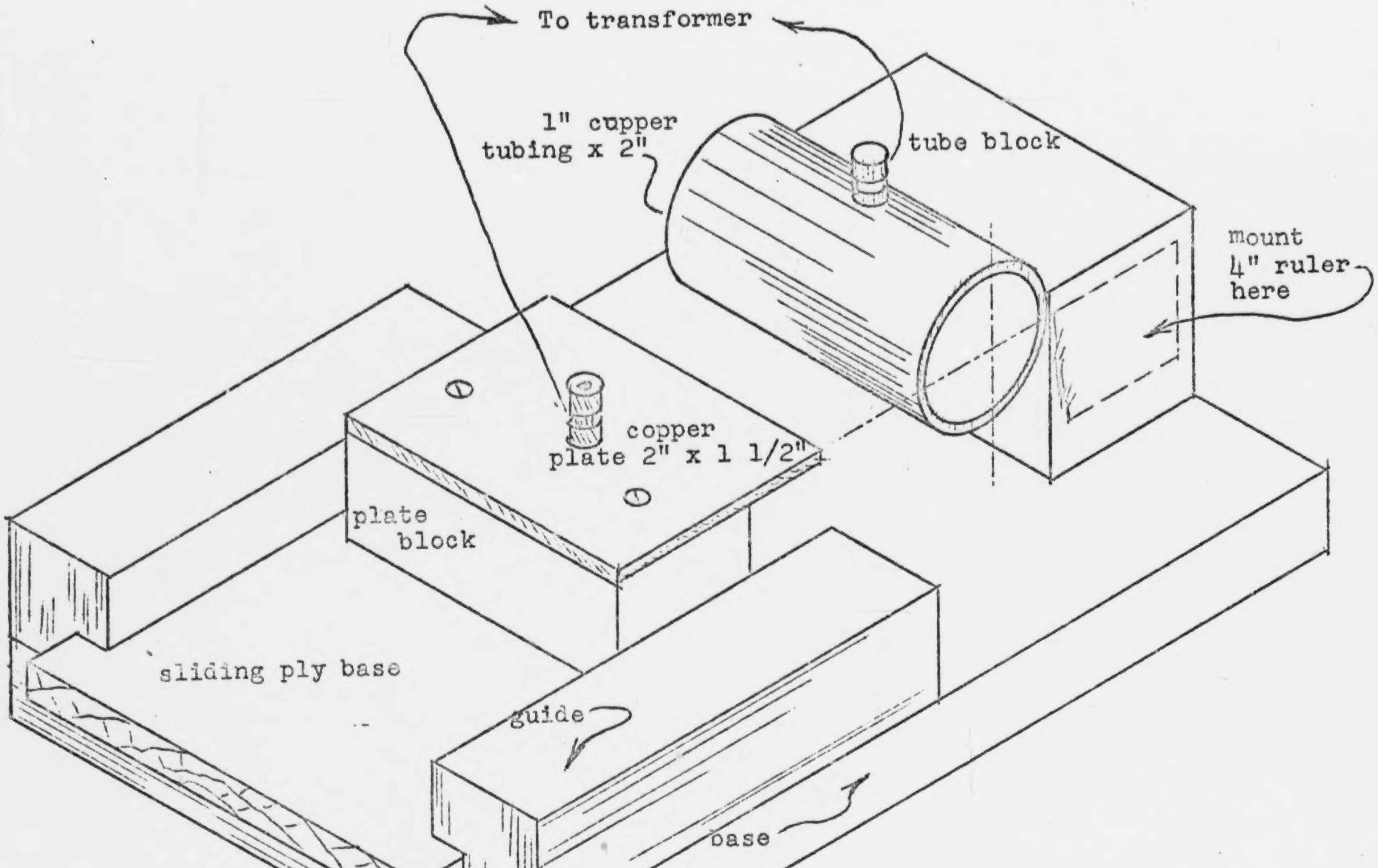
The apparatus consists of a high voltage transformer with about an 8000 volt secondary. A testing arrangement which enables a varying of the distance between the electrodes and a means of controlling the input voltage to the transformer.

The electrodes consist of a movable copper plate The sample to be tested is fixed to the copper tube and the metal plate is moved toward the tube until an arc occurs

Materials

1 - base 1/2" plywood 4" x 6"
1 - copper plate 2" x 1 1/2" x 1/16"
1 - 1" copper tubing 2" long
1 - 4" section of ruler
2 - terminal posts - binding type
2 - guides 3" x 3/4" x 3/4" with 1/4" rabbet along axis
1 - plate block 2" x 1" x 1"
1 - tube block 2" x 1" x 1 1/4"
6 - 3/4" #8 FH wood screws
2 - 8-32 x 1 1/4" machine screws
2 - 8-32 wing nuts

INSULATING VALUE OF NON CONDUCTIVE MATERIALS


To transformer
1" copper tubing x 2"
tube block
mount 4" ruler here
copper plate 2" x 1 1/2"
plate block
sliding ply base
guide
base

Project - From Sun to Sound

A science kit developed by Bell Telephone Laboratories for use by high school students. This kit will provide some basic experience in electrical circuitry and construction of components for an electric circuit.

Project - Solar Energy a science kit developed by Bell Telephone Laboratories. This is an involved activity where the group will have to construct a simple high temperature furnace and make their own solar cells.

INDUSTRIAL PREP ENGLISH

JUNIOR YEAR

Industrial Prep English - Junior Year

The Desires and Needs of Students is the Number One Consideration for Any Curriculum Change.

The past two years in Industrial Prep English has shown that a curriculum that does not specifically take into account the desires and needs of the students for whom it is intended, cannot be successful. It is evident that students in this course learn only when they see the need and feel a desire for learning.

The Industrial Prep English Curriculum in the Junior Year attempts to start from this point and establishes a program built around the student.

The purpose is not to fit the student into a desired mold, but rather to enable each boy to develop his own abilities and interests as he sees fit within the broad framework of an English course. Instead of attempting to change the boy, the philosophy is to revise the curriculum and school environment so that the student may naturally develop and take his proper place in the world.

Though doubts may be cast as to the reality of such a program, a journey most commence with one step and this English Curriculum is that initial step.

The Automobile and Television Set Probably Teach the Student More Than the School Teacher

In the preceding year it was clearly recognized that the number one interest of the Industrial Prep boys was cars. Because of this fondness the teaching of any number of traditional concepts, even with an excellent and stimulating teacher, made little or no conceivable impression because the students simply did not wish to learn that which they could not see as useful. Consequently a curriculum that wishes to be successful must take this car-mania into consideration.

A significant observed point was that as the boys matured their interest in the automobile industry as a means of earning a living waned. As the boys approached seventeen their major interest in life no longer was cars though their desire for an automobile increased. The car was no longer desired for itself, but as a symbol of independence, power, and sex.

Based on these drives the boys took after school jobs to earn enough money to buy and support their cars and this opened any number of ancillary fields which the curriculum planner took advantage of, i.e. taxation, installment buying, insurance, future jobs and laws.

Another interest of the boys was television. This was not the television that their teachers watched, but the shows that many adults would term foolish. Television was a favorite pastime for the boys because it was free, near, convenient and a "cool medium." They watched it not to be motivated, challenged or inspired, but to relax, dream and be amused.

The Content and Concern of English Remains the Same, But the Approach Differs.

Because of the preceding observations the purpose of the Industrial Prep English program has not necessarily changed from last year. The avowed purpose remains to teach Industrial Prep students how to read, write, speak, listen and think with as much discernment and discrimination as possible, so that they will be able to adaquately function in society.

What is changed from last year is the approach to achieving these goals. Originally it was thought that the broad eight areas of English, reading, literature, and composition, mass media, critical thinking, speech, listening and linguistics, would appeal to the student given an intelligent, interesting teacher who chose appropriate illustrations from each area.

In most cases the program proved successful. Basically the boys were willing to respond if the particular area under discussion was one that they felt filled a present active need, i.e. reading the help wanted ads & evaluating car advertisements.

Consequently the current approach is to use the content of the eight areas as a guide, and to search for unit topics for the students that will:

1. take into consideration their interests
2. fulfill their present and future needs
3. be sufficiently pragmatic to them
4. place more of a physical burden on the individual
5. broaden their horizons
6. continue to act as a forum for divergent points of view

7. correlate material with the rest of the Industrial Prep program
8. keep the philosophy of the Industrial Prep program in mind

In each of the units, some of the eight areas of the Hackensack High School English Curriculum are present, and in the complete Junior Year program all of the eight areas are included.

A Unit Approach is Suggested

The Junior Year is divided into five units which will provide sufficient material for the academic year.

Potentially the most far reaching unit is the one on Work Preparation. Here the boys will not only read about future jobs and hear speeches from the work field, but they will correspond with people requesting information, go outside the school to interview people and eventually spend one day "on-the-job" in the field of their choice.

Since the students spend much time with their television sets, the unit on Television provides for an analysis of the medium considering its effects on people, viewing it for more enjoyment and understanding and finally establishing criteria for evaluating shows. The practical part of this unit will be the preparation of a television commercial by the students.

In another unit an attempt is made to correlate English and Physics based upon the Physics Testing Project. The English contribution to this unit will be to have students explain their projects in written and oral work and to relate them actually to industry. To do this means that the boys will search for companies that use their models for actual testing procedures. Finally the boys will visit the companies and see the practical application to their project.

The Economics unit is an extention of the curious attention that students show in a study of the stock market in the Sophomore Year. For the Junior Year the topic of consumer credit revolves around the boys' desires to buy cars. This unit will correlate with the mathematics class where the computations involved in consumer credit will be taught while the English teacher presents such elements as car selecting, and arranging for and maintaining payments.

Finally a unit that takes advantage of the current issues of prejudice will round out the year. The boys, many of whom are Negro, will explore the realistic situation of prejudice through literature, psychology and practical experience. The classroom will provide a sounding board for the boys on many of today's racial issues.

These units are an attempt to further improve the teaching of English for non-college bound students and to establish a practical Industrial Prep Curriculum in Hackensack High School. Just as more insight was gained by the practical application of this curriculum in the Sophomore Year, so it is expected that increased knowledge will be gained as a result of applying this curriculum to the Junior Year.

Industrial Prep English

Junior Year

TABLE OF CONTENTS

I. Unit One - Work Preparation - P. 7

II. Unit Two - Television -- P. 30

III. Unit Three - Physics -- P. 42

IV. Unit Four - Economics -- P. 57

V. Unit Five - Prejudice -- P. 99

Junior Year

Industrial Prep English
Unit One

Work Preparation

I. Self-Awareness Exploration (Guidance-not in this section)

II. Scheme for Occupational Analysis

III. Library Research

IV. Letter Writing

V. Interviews

VI. Evaluation of Schools

VII. Automation

VIII. Literature

IX. Projects

Scheme For Occupational Analysis

I. Information

  A. Sources

    1. Libraries
    2. Companies
    3. Unions
    4. State Employment Agencies

  B. Bibliography

    1. Name of Pamphlet or Book, Author or Editor, Copyright or printing date, Publisher, City, State.

II. Requirements of the Job.

  A. Entrance and Advancement

    1. Unions
    2. Licenses
    3. Tests
    4. Discrimination

  B. Personality Necessary or Essential For Success

    1. Introvert-Extrovert
    2. Indoorsman-Outdoorsman
    3. Group-Solitary Setting

  C. Preparation necessary and where it may be obtained.

    1. Schooling
    2. Apprenticeship

  D. Abilities necessary or essential for Success

    1. Manual Skill
    2. Reading Ability
    3. Blueprint Reading

III. Demands and Rewards of the Work Environment

  A. Physiological Demands of the Job

    1. Bodily Movements and Strain

    2. Use of Tools

    3. Noise

  B. Physiological Rewards of the Job

    1. Improvement of Physical Condition

2. Sharper Reflexes
3. Better Health

C. Psychologial Demands of the Job.

1. Pressures
2. Mental Effort
3. Deadlines

D. Psychological Rewards of the job.

1. Satisfaction
2. Pride

E. Compensation

1. Range of Pay-hour, day, week, month, year.

2. Amount of time before top money is reached

3. Fringe Benefits

F. Working Conditions

1. Health Rooms

2. Recreation

3. Physical Layout of Building

4. Special Uniforms Required

G. Advantages and Disadvantages of working in the field.

IV. People in the Field

A. Background

1. Amount of Education

2. Age Bracket

3. Ethnical Background

B. Association of Workers

1. Labor Union

2. Credit Unions

3. Social Context

V. Outlook

A. Distribution of Workers by Number and Geography

1. Company

2. Region

3. United States

4. World

B. Future trends in employment in the field

C. Related fields for the future.

The Library

I. Finding Books

A. Dewey Decimal System

1. 000-099-General Works-Encyclopedias-periodicals
2. 100-199-Philosophy-psychology-ethics-logic
3. 200-299-Religion-Bible-Churches-Church history-mythology
4. 300-399-Social Science-Economics-law-government
5. 400-499- Linguistics-Dictionaries-grammars
6. 500-599-Pure Science-Mathematics-Chemistry-Physics.
7. 600-699-Applied Science-Medicine-Aviation-Business.
8. 700-799-Arts and Recreation-Sculpture-painting-music.
9. 800-899-Literature-Novels-plays-essays.
10. 900-999-History-Geography-Travel

B. 600-699- Applied Sciences

1. 610-Medicine
2. 620-Engineering
3. 630-Agriculture
4. 640-Home Economics
5. 650-Business
6. 660-Industrial Chemistry
7. 670-Manufactures
8. 680-Mechanic Trades
9. 690-Building

C. Industrial Chemistry

1. 666 Ceramic Technology
2. 667 Cleaning or Dyeing
3. 668 Other Organic Products

4. 669 Metallurgy

D. Fiction

1. Marked F
2. Alphabeticalby Authors
3. Books by same authors are then listed alphabetical order.

E. Biography

1. Listed by letter "B" or 92
2. Collective Biographies 920

Exercises-A. Pick the Dewey System Subject Heads for the following books.

1. Boris Sokoloff- Miracle Drugs
2. Frank Magruder- American Government
3. Selig Hecht- Explaining the Atom
4. Will Durant- The Story of Philosophy
5. Thor Heyerdahl- Kon-Tiki
6. Florence Fitch- One God-The Ways we Worship Him
7. Lucile Marshall- Photography for Teen-agers
8. Wilfred Funk- Word Origins and their Romantic Stories
9. Charles Lamb- Essays of Elia
10. World Book Encyclopedia

B. Sometimes Non-Fiction books do not give a clear indication of what they are. Decide which choice accurately describes each book.

1. 13 Against Odds- 920 (a) hazards of mountain climbing
   (b) collective biography of Negroes
   (c) teamwork in rowling

2. 26 Letters-411 (a) model business letters
   (b) personal letters of T.R.
   (c) the story of the alphabet

3. Fun with Figures (a) Math problems
   (b) exercising for reducing
   (c) modeling as a hobby

4. Green Pastures 812 (a) a play
   (b) a biography of Louis Pasteur
   (c) soil conservation

5. Rameses to Rockefeller 720.9 (a) a collective biography of outstanding people in many fields
   (b) the story of architecture
   (c) a one volume World History.

II. The Card Catalogue-Tells student where the book is located in the library shelves.

   A. 3 types of card

      1. Title

      2. Subject

      3. Author

   B. Cross Reference

      1. "See"- means library lists books under different subject.

      2. "See Also"- Additional Material listed under another subject.

III. Reference Books- they answer Specific questions i.e.

Who is the World Champion discus thrower?

Did Mrs. O'Leary's cow start the Chicago fire?

What is the legal voting age in Nebraska?

What is required for a fireman's license in N. J.

   A. Encyclopedias- Almost any subject-contains general information-written by experts.

      1. Britannica

      2. Collier's Encyclopedia

      3. Encyclopedia Americana

      4. Comptons's Pictured Encyclopedia (high school)

      5. World Book Encyclopedia (high school)

   B. Biography

      1. Dictionary of American Biography (Dead Americans)

      2. Dictionary of National Biography (Dead English)

      3. Who's Who (English)

      4. Who's Who in America

      5. Webster's Biographical Dictionary (All nations, all times)

C. Yearbooks- Facts- Sports records- Award Winners- important dates.

   1. World Almanac

   2. Information Please Almanac.

D. Atlases- Geography

   1. Goode's World Atlas

   2. Rand McNally- Cosmopolitan World Atlas

   3. Hammond's Library World Atlas

E. Quotations

   1. Bartlett's Familiar Quotations (Listed by author)

   2. Stevenson's Home Book of Quotations (listed by subject)

F. Occupational

   1. Occupational Outlook Handbook-U.S. Bureau of Labor Statistics.

   2. Job Guide for Young Workers-U.S. Employment Service

   3. Career Index- Chronicle Guidance Publications

   4. Ulrich's Periodicals Dictionary-edited by Granes (Technical Journals)

G. Vertical File- Current topics-pamphlets-newsclippings

III. Magazines- Reader's Guide to Periodical Literature

O'Brien, Robert

Now you can bet on the weather and win, more often
Read Digest 88:125-8 Je '66
What's so different about CB antennas?
Pop Elect 24:44-61 My '66

Occupations
Boom in jobs for 1966 graduates. U.S. News
60:123 Je 13 '66

See Also
Airlines- Employees

Education

————Europe, Western

————Europe's Schools going American? (il) (US News) 60:77 Je 13 '66

United States

Education in America: (by P. Woodring- J. Lass)

Window on the World
791.45
C
Coombs, Charles I.

Windows on the World; the story
of television production;

World Pub. 1965
125 p. illus.

791.45
C
Coombs, Charles I.

Window on the World; the
story of television production;

World Pub. 1965
125 p. illus.

Television: Production and Direction
791.45
C
Coombs, Charles I.

Window on the World; the story
of television production;

World Pub. 1965
125 p. illus.

Letter Writing

I. Form
  A. Heading
  B. Inside Address
  C. Salutation
  D. Body
  E. Closing
  F. Signature

II. Letter of Request
  A. Request Information i.e. Who? What? Where? When? Why? How Many?
  B. Supply Accurate Information-i.e. date, time address? title?
  C. Reasonableness
    1. Investigate your information
    2. Know enough to be specific
    3. The man you are corresponding with knows his field.
  D. Be Courteous
  E. Be Brief

III. Letter of thanks
  A. Be prompt
  B. State thanks
  C. Show how the courtesy of the man will be beneficial to you.
  D. Be sincere

comma spell out

352 Hackensack Avenue
Hackensack, New Jersey 07601
September 30, 1967

date

skip space

Mr. Carl Jones
Hackensack High School
First and Beech Streets
Hackensack, New Jersey 07601

skip space colon

Dear Mr. Jones:

indent This is a standard letter style which you may use for any business letter. Note that it is well-balanced and neat. Some of the areas that students have trouble with are pointed out.

margin

indent Many times the first picture a future employer may have of you is with your letter or application or request. Just as a poor picture of yourself in the school yearbook will make a bad impression on people, so to a poor letter submitted to a prospective employer will not make a very satisfactory impression. It is really very simple to write a good letter if you know how.

margin

capitol letter

complimentary closing Sincerely yours, small letter comma

signature → Joseph Smith

Joseph Smith
Instructor

margin

Interview

I. Arrangements for Interview

- A. Have I sufficient background to conduct the interview?
- B. Is the topic worthwhile?
- C. Is the topic stated clearly?
- D. What specific information do I seek?

II. Questioning

- A. Preparation
  1. Prepare as many questions as possible.
  2. Organize the questions into major topics.
  3. Pick the more important questions as your interview questions.
- B. Questioning Procedure
  1. Require more than a "yes" or "no".
     - a. Wrong--"Is a college education necessary?"
     - b. Right--"What amount of education is necessary in order to qualify for the field?"
  2. Have the interview go into detail-(Avoid Silence)
     - a. Wrong--"Oh, you say it is necessary to go to a technical school?"
     - b. Right--"If I go to a technical school, what specific courses should I take?"
  3. Ask single questions.
     - a. Wrong--"When, Where and how does a person enter this field?"
     - b. Right--"How does one enter this field?"
  4. Get an Opinion--Do not give one.
     - a. Wrong--"Since the best paying jobs are on the east coast, shouldn't a boy look for a job on the east coast?"
     - b. Right--"Where is the best Region to find a job?"
  5. Make sure questions are pertinent-Stick to the Topic.
     - a. Wrong--"Mr. Bell, do you think Hackensack has a good school system?"

b. Right--Stick to questions concerning the interview.

6. Propriety

a. Wrong--"Mr. Bell, how old are you?"
b. Right--"Is the field different now than from the time you first entered it."

III. Note Taking

A. Write all questions on 3x5 index cards.

B. Write answers to questions immediately on index cards.

IV. Conducting Interview

A. Know your questions

B. Be businesslike

C. Do not rush

D. Let the interviewer do the talking

E. Listen to the interviewer

F. Stay flexible

G. Stay on topic

H. Take Notes

I. Check your notes with interviewer if something is unclear.

V. Tact

A. If the answers are vague have the interviewee restate his answer.

a. Wrong "You did not answer my question."
b. Right "I'm sorry I do not understand."

B. Try to keep to the topic by using transitional questions.

a. Wrong-"Yes, I would like to talk about our football team's prospects, but could we get back to the topic?"
b. Right-"Do you place any particular value in a boy who participates in extra-curricular activities?"

VI. Post Interview Procedure

A. Organize your information immediately after your interview.

B. Write a Thank-you note to interviewee.

C. Prepare your report to the class.

VII. Grooming.

A. Wear a suit or sport jacket, white shirt and tie.

B. Make sure clothes are cleaned and pressed.

C. Have a well-groomed hair-cut.

D. Have shined shoes.

School Evaluation

I. School Administration

- A. What kind of school is it? i.e. Technical, Business, or Junior College.
- B. Who administers the school? i.e. State, City, a private corporation, or a religious order.
- C. Is the school accredited by the State?
- D. Has the school issued a catalogue? Take one.

II. Facilities

- A. Where is the school located? i.e. State, City? What part of the city.
- B. What did you notice about the building or buildings? i.e. Layout of building, number of floors, laboratories, classes.
- C. What kind of furniture does the school have in each classroom?
- D. What kind of lighting fixtures in the school?
- E. Does the school have a library?
- F. Is the school in a state of cleanliness?

III. Costs

- A. What is the tuition per school year?
- B. What is the cost of the school per basic unit of instruction?
- C. Are there any school dormitories?
- D. If so, what is the cost of Room and Board per school year?
- E. If the school is a commutor school, is there a cafeteria available in the school?
- F. Is the school easy to reach by transportation? Public, Private Transportation.
- G. If so, what is the cost of transportation from your house?
- H. Is any financial assistance offered to the student by the school?

IV. Entrance

A. What are the entrance requirements? i.e. High School Diploma, Tests, College Boards.

B. When may a student enter a school to begin instruction?

V. Students

A. How many students are registered for courses?

B. What is the make-up of the student body? i.e. Male-Female, Young-Old.

C. Where do they live?

D. How do they dress?

E. Are there any social activities available for students?

VI. Program of Study

A. What Programs of Study are offered? i.e. Electronics Technology, Chemical Technology, Data Processing.

B. Within your Program of Study what are some of the courses offered to you? i.e. In Chemical Technology-some of the courses may be General Chemistry, Quantitative Analysis, Organic Chemistry, Geometry.

C. How long is the training program?

VII. Classes

A. How long is class in session for one period?

B. How many sessions a week do the classes meet?

C. How many weeks in the academic year?

D. What are class sizes?

VIII. Staff

A. What type of teacher in the school? i.e. Male, Female, Old, Young.

B. What are the Educational and Work backgrounds of the teachers?

C. Are the teachers certified by the State?

IX. Placement

A. Does the school attempt to place its graduates upon graduation?

B. Does the school say it will guarantee its graduates a job?

Automation

I. Definition

A. Production System

B. Uses hydralic, pneumatic, mechanical, electronic or other related equipment

C. Regulates, Shortens and Coordinates Production

D. Examples of Automation Devices
1. transmissions in cars
2. thermostats for furnaces
3. street lighting
4. electricity
5. alloying of metals
6. chemical synthesis

II. Need for Automation

A. Massive increase of U.S. population

B. Increased production to meet popular demand

C. Maintaining and improving standard of living

D. Space Program

III. Computers-

A. Speed-7,000 computations per second

B. Third Generation
1. Mark I
2. Eniac-30 tons-1500 square feet of space
3. Transistors - 1958
4. Not human but extends human capabilities

C. What computer does
1. Caluclates
2. Shoulders work assignments
3. Monitors complex processes
4. Prints material

D. What a computer cannot do
1. It must have instructions from humans before it can function.
2. Men must draw inferences from information given by computer; the computer cannot reason independently.

IV. Industrial Work

A. Employment

1. Because of the many variables involved, can the influence of automation on employment be adequately judged?

2. Has it changed skills needed in labor market?
3. Are jobs less meaningful?
4. Are workers less responsible?
5. Are results less personally rewarding for a skilled craftsman? for an unskilled laborer?
6. Do workers become obsolete?
7. Is the human brain devalued?

B. Industry
   1. Alternative is obsolescence
   2. New products
   3. Adaptations of new techniques to traditional products
   4. Adaptations of new materials to traditional products.

C. Fields of the Future

D. Literary Pieces With Work & Automation Theme

   1. R.V.R. by Karl Caprek
   2. Stories for Youth- ed. A.H. Lass & Arnold Horowitz
      a. Wrong Guy by William B. Mahoney
      b. Quality by John Galsworthy
      c. The Pod of a Weed by Forrest Rosaire

A fine book for students is Stories for Youth, edited by A.H. lass & Arnold Horowitz, McGraw-Hill Book Company, Inc, N.Y., N.Y.

Here is an example of what discussion questions Quality can provide.

1. Why is the attitude of Gessler towards his work unusual?
2. What type of workers take pride in their workmanship?
3. How is Gessler different from the average factory worker?
4. Why doesn't everyone have pride in his work?
5. Can men like Gessler succeed in today's society?
6. Why didn't more people purchase shoes from Gessler?
7. Would you have purchased your shoes there?
8. Should Gessler have covered his standards of workmanship?
9. What is success?
10. Was Gessler successful?
11. Do you admire him?
12. If Gessler had a wife and two children would he have had a different outlook on life?
13. Is mass production a desireable characteristic of modern society?
14. What are some advantages and disadvantages of mass production?
15. What will make an assembly line worker produce superior quality?
16. The U.S. Department of Labor reports 35,000 jobs go out of existence everyday, what happens to the men in these jobs?
17. Even though 35,000 jobs go out of existence everyday more than that are created by new industries. Who fills there new jobs?

Flick Webb
by John Updike

Pearl Avenue runs past the high-school lot,
Bends with the trolley tracks, and stops, cut off
Before it has a chance to go two blocks,
At Colonel McComsky Plaza. Barth's Garage
Is on the corner facing west, and there,
Most days, you'll find Flick Webb, who helps Barth out.

Flick stands tall among the idiot pumps--
Five on a side, the old Bubble-head style,
Their rubber elbows hanging loose and low.
One's nostrils are two S's, and his eyes
An E and O. And one is squat, without
A head at all--more of a football type.

Once, Flick played for the high-school team, the Wizards.
He was good-in fact, the best. In '46
He bucketed three hundred ninety points,
A county record still. The ball loved Flick.
I saw him rack up thirty-eight or forty
In one home game. His hands were like wild birds.

He never learned a trade; he just sells gas,
Checks oil, and changes flats. Once in a while
As a gag he dribbles an inner tube,
But most of us remember anyway.
His hands are fine and nervous on the lug wrench.
It makes no difference to the lug wrench, though.

Off work, he hands around Mae's luncheonette.
Grease-gray and kind of coiled, he plays pinball,
Sips lemon cokes and smokes those thin cigars.
Flick seldom says a word to Mae, just sits and nods
Beyond her face toward bright applauding tiers
Of Necco Wafers, Niba, and Juju Beads.

1. What is Flick's job at the time of the poem?

2. What sport did Flick play in school?

3. What does the word "Flick" suggest? the word Webb?

4. To what does the poem compare or contrast Flick?

5. What does the following line of the poem mean?--
"One's nostrils are two S's, & his eyes
An E and O.

6. How has Flick used his skills & education since high school?

7. How is Flick like Pearl Ave?

8. What kind of life lays ahead for Flick Webb?

9. What does Flick Webb think about himself?

10. What ideas does the poet try to evoke from the reader?

Possible Student Projects for Work-Preparation Unit

I. Oral

  A. Group Interviews

    1. Students interview a school administrator or teacher on some phase of school life.

    2. Students interview a man who works in industry.

    3. Students interview a person who the guidance counselor feels can reenforce a point that has presented in class guidance period i.e. a physically handicapped person who has successfully overcome his handicap.

  B. Individual Interviews

    1. Student interviews a person who they personally know and respect i.e. priest, relative.

    2. Student is sent to interview an industrial worker on-the-job in a field that student desires to enter upon graduation.

  C. Reports

    1. Students follow-up any individual information they have gathered by reporting to the class.

    2. A representative from the New Jersey Employment Service talks to the students about topics in which they cannot get information i.e. Further outlook in the Technical fields, Geographical Distribution of workers, Unionism in the Work Field.

II. Writing

  A. Letters

    1. Letters are written to Unions and Companies requesting information.

    2. Students write to men in industry requesting interviews.

    3. Students write Thank-you letters to people who have helped them with their units.

    4. In conclusion students write a report about their chosen field consolidating all the information they have received.

III. Schools

  A. Students take a trip to a number of technical schools in the local area and evaluate them.

Junior Year

Industrial Prep English

Unit Two

Television

I. History

II. Advertising

III. Viewing

IV. Judging

V. Types of Shows

VI. Effects of Television

VII. Projects

TELEVISION

I. History

A. Samuel F.B. Morse-The Telegraph-1844

1. Cables
2. Dots and Dashes

B. Alexander Graham Bell-Telephone-1876

1. Cables
2. Speech

C. Thomas A. Edison-Phonograph-1877-preserved speech

D. Guglielmo Marconi- Wireless- 1901

1. No Cables
2. Dots and Dashes

E. Fessenden de Forest

1. No Cables
2. Speech

F. Post World War I-The Radio

1. Conrad
2. KDKA
3. WEAF- Advertising
4. NBC-1926
5. CBS-1927

G. Orson Welles- October 1935

H. Post World War II. period - Television

I. Government Regulation-F.C.C.

II. Advertising

A. Types
1. Complete Program
2. Participation in a program
3. Spot Announcement

B. Advantages
1. No government control
2. Free Television for the consumer
3. Great deal of money is spent on television shows
4. Choice of programs available

C. Disadvantages

1. Program of interest to sponsor
2. Sponsor as censor
3. Interruptions
4. Too much propaganda

III. Viewing Television
  A. The passive viewer
    1. merely sensual
    2. short attention span

  B. The appreciative viewer
    1. takes active interest
    2. emotionally involved
    3. attentive

  C. The analytical viewer
    1. on an intellectual level
    2. is absorbed into the program
    3. questions about program are answered

  D. The critical viewer
    1. on an intellectual level
    2. evaluates plot, theme, and characters
    3. compares and contrasts program with other programs
    4. evaluates production level i.e. camera, lighting, acting

IV. Judging Television

  A. Purpose
    1. Education
    2. Entertainment
    3. Propaganda

  B. Criteria
    1. Originality
    2. Reasonableness
    3. Message
    4. Stimulation
    5. Permanent Value
    6. Purpose

  C. Rating Services

    1. Different professional organizations that rate shows.

    2. Division of viewers

      a. age
      b. economics
      c. sex
      d. religion
      e. race
      f. education
      g. geography

  D. Influence of television on Ideas of Viewers
    1. social customs
    2. family life
    3. marriage
    4. dress
    5. etiquette

6. cultural and social groups
7. nations

V. Types of Shows

A. General Characteristics of Shows

1. 26 or 52 minutes
2. commerical
3. immediate interest
4. focus on people
5. action
6. family entertainment
7. live or taped

B. Family Shows

1. How are the various characters depicted?
    - a. Parents-
        1. job?
        2. dress?
        3. in-laws?
        4. discipline of children?
        5. smoke?
        6. drink?
        7. sensitivity to problems?
        8. interests?
        9. friends?
        10. who is the smarter?
        11. who is the more sensitive?
        12. who is the more refined?
    - b. Children
        1. school?
        2. sports?
        3. social life?
        4. cars?
        5. ambitions?
        6. friends?
        7. relationships with parents?
        8. siblings?
2. Economic Status of Family-
    1. prosperous?
    2. car?
    3. house?
    4. maid?
    5. butler?
    6. number of children?
    7. vacations?
    8. furnishings of house?
3. Cultural Identification
    1. religion?
    2. politics?
    3. racial issues?
    4. education?
    5. culture?

4. Problems-
    1. social and political issues?
    2. What kind of problems?
    3. How are there problems solved?

5. Values-
    1. friendliness?
    2. tolerance?
    3. patriotism?
    4. respect?

6. Comparism between real families and television families.

C. Westerns-
    1. Comparison of Children's and Adult's Westerns
        a. Virtues and Vices
        b. Good and bad characters
        c. Symbols
        d. Plot
        e. Theme

    2. Historic Value
        1. Truth and Falsity of dates, people, geography, and occupations.

        2. Relationship between people.
        3. Indian Problem.

D. Cops and Robbers- Sherlock Holmes' descendants

    1. setting
    2. number and types of characters
    3. characteristics of hero
    4. plot
    5. moral tone

E. Comedy
    1. Shows
        a. What makes show funny?
        b. Is it successful? Why?
        c. Popularity.

    2. People
        a. What makes a comedian popular?
        b. What type of personality does he have?
        c. On what does he depend for his humor?
        d. Does he amuse?

F. Realism versus Fantasy
    1. What is the difference between realism and fantasy?
    2. Are there more realistic or fantasy shows on television.
    3. Any danger of watching fantasy shows on televisior
    4. Why have fantasy shows on television?

VI. Effects of Television
    A. On Children
    B. On Adults
    C. On other media
        1. the newspaper
        2. the form and use of radio was changed.
        3. films- effected quality and amount of films.
            a. In 1946-82 million people attended the movies.
            b. In 1955-46 million people attended
            c. In 1963-47.5 million people attended

PROJECTS

I. Possible

Harris Survey-1965	more %	less %	about same %	own no t.v. %
Total Adults-	34	33	31	2
Source of				
T.V. Loss:				
Suburban Residents	26	38	35	1
College Educated	31	39	28	2
21-34 age group	34	40	25	1
Income of $10,000	22	48	30	
Source of				
T. V. Gain:				
Small town residents	43	23	32	2
grade school educated	34	23	32	2
50 and over age group	44	20	31	5
$5,000 and number income	42	25	28	5

A. Why a loss a gain in many groups? Discuss reasons.
B. Generalizations from statistics?
C. How would this survey effect the television industry?

II. Cross Media Analysis Projects

Note: Many of the following projects are based on the following book:

TELEVISION AND THE TEACHING OF ENGLISH

by Neil Postman and the Committee on the Study of Television of the National Council of Teachers of English- Appleton-Century, Inc. New York, N.Y. - 1961.

A. Character

1. How has the leading character been changed? i.e. more likeable?, handsome?, younger?, wealthier?, more forceful?.

2. Have minor characters been eliminated, added, or substantially altered?

3. Have relationships between characters been changed? i.e. has a brother become a friend in the television adoption.

4. Have other identifying characteristics been altered? i.e. has a communist become simply a "radical!"

B. Setting

1. Has the place of the events been changed? i.e. Has Mississippi become somewhere in the South?

2. Have the settings been made more luxurious or more poverty stricken.

3. Have names been added or omitted?

C. Language

1. Have profanity or obscenity been removed?
2. Have simpler or more explicit explanations been used?
3. Has dialogue been transferred from one character to another?
4. Has a descriptive passage been transformed into dialogue?

D. Theme

1. Has the original theme been eliminated or altered?
2. Has the theme been made more explicit?

E. Structure

1. Have incidents been added or omitted?
2. Have action sequences been expanded or compressed?

F. Ethical and Moral Standards

1. Has virtue been made to triumph and sin been punished?

III. Survey of T.V. Viewing- Audiences

A. What types of television shows are on between the following hours?

1. 9:00 a.m. to 4:00 p.m.
2. 4:00 p.m. to 7:30 p.m.
3. 7:30 p.m. to 11:00 p.m.
4. 11:00 p.m. to ?
5. Weekend television

B. What specific group of people watch television during each of these hours?

C How does this influence the television industry?

D. Would you say that the audience's viewing habits influence the industry or that the television industry influences the audiences viewing habits?

E. Using the chart make a diary of your viewing habits for one week. See if your habits correspond to your classmates' habits?

F. Find out why people watch television or why people do not watch television?

G. List all the different types of television shows that are available to viewers. i.e.

a. news
b. movies
c. children's shows
d. situation comedy
e. sports
f. interviews
g. quiz
h. drama
i. variety
j. comedy
k. religious
l. teenage dance instruction
m. soap opera
n. detective-police
o. documentary
p. science-fiction
q. spy
r. western
s. adventure-serious
t. adventure-comedy

H. Why are some types more popular than other types? Would you say that the audience knows what it wants and the television industry presents these types of shows or that the audience does not know what it wants but lets the television industry decide for it?

CHART FOR TELEVISION STUDY

SUN	CH	MON	CH	TUES	CH	WED	CH	THUR	CH	FRI	CH	SAT	CH	TIME
														Before 7:30
														7:30-8:00
														8:00-8:30
														8:30-9:00
														9:00-9:30
														9:30-10:00
														10:00-10:30
														10:30-11:00
														After 11:00

IV. Advertising- Television and the Teaching of English by Neil Postman

A. Provide a description of each commercial including its setting, language, music, the type of people in it, or the activity in which they are engaged.

B. Describe the product being advertised and the responces of the people in the commercial to the product.

1. What needs or Desires are appealed to? i.e. social acceptance?,.. social?, acceptance?, good health?, independence?, economic?, security?, comfort?, time saving?.

2. Which of the seven propaganda techniques is used by the advertiser? Why?

3. Are there any implied consequences of one's failing to purchase the product? Will one lose dates? Fail to get married?, spend money, or time and energy needlessly?

4. Are these consequences of importance to American Society? to you and your family?

5. Does the commercial fit in with the content of the program it serves i.e. Geritol sponsors Lawrence Welk, but Winston does not sponsor Captain Kangaroo.

6. Would it matter if this commercial were presented at a different time slot?

This unit does not have to stop here, but can also evaluate reactions of people to advertising in general i.e. newspapers, films or books. Included in this might be a unit on stereotyping.

V. Criticism--Have students write their own criticism of a television show based on the following questions or topics:

A. Summerize the plot of the show
B. State the theme of the show
C. Compare and contrast this show with a similar type of show based on the following topics--1)plot, 2)theme, 3)characters-(number, type, personality) 4)acting.

VI. Have the students identify the important professional television critics in the local area. The students will then examine the critics' methods of criticism and finally make a judgement about their general competence.

The students will evaluate the critics based in the following form:

- A. Does the critic accurately summerize the plot?
- B. Does he tell what the theme or purpose of the show is?
- C. If he does not tell what the theme or purpose of the show is, does he say why he does not speak about this?
- D. Does he compare or contrast this show with another of the same type? (characters, setting).
- E. Does he talk about acting, producing, directing?

VII.F Have students produce a 30 second advertisement on some particular product or service related to a school activity. Students can be divided into producers, directors, writers, actors, and technicians. The resulting product will be put on film and presented to the student body.

VIII. G. Take students to a New York Television Station.

IX. For the literature part of the unit, read some original television dramas and discuss them from two points of view: 1) the purely literary content 2) from the television production view. Some parts of the plays may be acted in class. Over the years a number of good plays have been produced. i.e. Requiem for a Heavyweight by Rod Serling, Twelve Angry Men by Reginald Rose
Visit to a Small Planet by GoreVidal
The Final War of Olly Winter by Ronald Ribman

A paperback book to use is Best Television Plays-edited by Gore Vidal

Junior Year

Industrial Prep English
Unit Three

Physics

I. How To Describe

II. How To Define

III. Critical Thinking - (Inductive Reasoning)

IV. Listening Faults

V. Physics Project

VI. Science Fiction Literature

PHYSICS PROJECT

How to Describe

I. Use of the Five Senses

  A. Sight
    1. size
    2. shape
    3. color
    4. Can it be recognized by any of the above?

  B. Touch
    1. What is the weight of the object?
    2. What texture does it have?
    3. Is the texture significant to the object?

  C. Sound
    1. Does it make a sound by itself?
    2. What sound is made by striking it?
    3. Are any of those sounds distinctive of the object?

  D. Smell
    1. Does it have its own peculiar smell?
    2. Can the object be identified by its smell?

  E. Taste
    1. Is there any taste to it?
    2. Can it be identified by its taste?

II. What is the purpose of the object?

  A. Where can it be used?
  B. How can it be used?

III. Parts and their inter-relationships

  A. Number of Parts
  B. Order of Space

IV. Objective Description

  A. Scientifially Precise
  B. Define terms
  C. Measurements

Exercise - Fully describe the following objects:
1) desk 2) chair 3) scissors

V. Subjective Description Opposite ot Objective

  A. What does object do?
  B. Where is the object located?
  C. May theorize about object based on what is known.

VI. Description of a Process

- A. Materials
- B. Purpose
- C. Steps
  - 1. Time
  - 2. Space
- D. Conclusion

1. Exercise

- a. Describe the cooking of spaghetti.
- b. Describe how to get to Main and Mercer Streets.
- c. Describe how to make a tie knot.
- d. Describe how to tie a shoelace.
- e. Describe how to change a flat tire.

2. Exercise

- a. Describe how a watch runs.
- b. Describe how a water faucet works.
- c. Describe the inner workings of the starting of a car.
- d. Describe how a pulley works.
- e. Describe how an automatic transmission works.

Philosophy of Description

I. Description of an Object

A. Definition

1. paint a word picture
2. give an accurate image
3. a photograph

B. Exercise

The description of a car as "beautiful" is vague. The car description can be made more vivid by specific definition i.e. A Mustang "Stallion" G.T. equipped hardtop coup, 225h.p., 289 V-8, styled steel wheels, red body with white vinyl roof.

II. Non-allness-We omit many details when we write or talk. We have a complex universe, but only a small vocabulary to describe it.

A. Many levels of the Universe

1. Macroscopic
2. Telescopic
3. Microscopic
4. Submicroscopic
5. Thoughts, feelings, relationships.

B. Can you describe all about a pencil? No!

1. wood
2. metal
3. graphite
4. uses
5. types
6. manufacturer
7. erasers

III. Evidence of non-allness

A. Read a story of Louis Aggasiz, who trained one of his science pupils to see things that people ordinarily miss.

B. Have students look up the number of books about Napolean and Lincoln.

C. Can you learn all about science?

1. Biological-Living
    - a. Botany-plant life
    - b. Zoology-animal life

2. Physical- Non-Living
    a. Chemistry-Composition of matter
    b. Astronomy-Sun, moon, stars, planets
    c. Meterology-weather
    d. Gelogy-earth
    e. Metallury -composition and structure of metals.

D. Physics

1. Mechanics
2. Heat
3. Sound
4. Light
5. Electricity
6. Nuclear Physics

IV. Does this mean if we can not know all about something,we should not act or come to a decision? No!

A. We act on the knowledge we have
B. There is always more to learn.

V. Details-Since we cannot get all details of anything, we must select some details and ignore others.

A. Send two pupils to the same office. When they return ask them individually describe the office. Notice the difference in details.

B. Have each student describe the classroom. What causes differences in details

C. Have students compare the N.Y. Times, The Record, and Our Town. Why are there differences and similiarities.

D. Have the students look at a picture and describe it. Do they all see the same thing?

VI. The details a person selects tells something about the item being described but more importantly it tells something about the person doing the describing.

Definition

I. There are many different meanings for words in the English Language.

A. You are always complaining. What a crab you are.

B. He cannot be trusted. What a rat he is.

C. What a mob we have. Our first heist & we got nabbed.

D. If you have a little mazel, you will lead a wonderful life.

E. He was involved in an auto accident and he kicked-the-bucket.

F. You may call it soda but from where we come from its pop.

G. You can go to the movies today, but I ain't going.

Exercise

1. Before looking up the meaning decide what these underlined words mean.
2. Find the dictionary definition of the words.
3. What labels does the dictionary give for the words? i.e. Slang, Formal English, Vulgar English, Standard English, Jargon.
4. Do dictionaries differ as to definitions and labels? Why?
5. Should a dictionary be a law or a history book?
    - a. law book
        1. set standards
        2. sets acceptability
        3. legislates
    - b. history book
        1. record common speech
        2. record acceptability and unacceptability
        3. describes langusge patterns

II. Words that mean different things to different people.

A. What does the work strike mean to:

a. a baseball pitcher
b. a batter
c. a union organiser
d. a company owner
e. a gold prospector
f. a General in the Army
g. a bowler
h. an automobile driver
i. a clock maker
j. a person who mints coins
k. a cigarette smoker
l. an automobile buyer
m. a commander of a war ship

B. What does the word rain mean to:

- a. a farmer
- b. a picnicker
- c. the weatherman
- d. a hairdresser
- e. a baseball pitcher whose team is losing in the third inning
- f. a baseball pitcher whose team is winning in the third inning
- g. a beach concessionnaire
- h. a bride
- i. the Hackensack Water Company

Exercises

1. Does a definition really help?
2. What else is involved in defining?
3. What does this tell us about a dictionary?
4. What should we be aware of when trying to define?

III. Sometimes some words are more specific.

- A. hot rod - car
- B. history - Social Studies
- C. student - pupil
- D. English - communication
- E. learning - memorizing
- F. books - literature

Exercises

1. What is the difference in meaning between each set of words?
2. When defining which type of word should be used?

IV. Formal Definition

- A. term - word to be defined
- B. class - group of similiar things or ideas to which terms belongs
- C. difference - the way in which a term differs from other members of the class

Exercise - Define each concrete object.

1. Triangle - Polygon with 3 sides
2. Circle - a geometric figure with a set of points equidistant from a given point
3. Water - a liquid that is oderless, tasteless, and colorless
4. Pencil - a writing instrument with a core of graphite
5. Book - a written material permanently bound together

Define each abstract object
1. Slavery -
2. Education -
3. Sportsmanship -
4. Democracy -
5. Evil -

A problem will arise here. The students will fine that one sentence will not adequately define abstract concepts, but that the definition must be extended.

V. Problem of Defining - Story of the six blind men and the elephant
   A. A definition cannot say everything about the term defined.
   B. Definitions are in some ways fallacious.
   C. Definitions have limitations.
   D. There are sometimes many definitions for one word.
   E. The definition we want may depend on the way we "see" it.

VI. Faults in Defining
   A. Do not be negative, be positive.
   B. Avoid the expressions "is when" and "is where".
   C. Do not define a word in terms of itself.

VII. Extending the Definition
   A. Exercise - What is your feelings toward the man as each part is added to a description of him?
      1. He has children.
      2. He is a Negro.
      3. He has been in jail.
      4. He has a moustache.
      5. He is involved with Civil Rights.
      6. He writes books.
      7. He is a preacher.
      8. He won a Nobel Peace Prize.
      9. His name is Martin Luther King.

   B. Exercise - We will start this exercise with the man's name. Do your feelings of the man change with each detail?

      The man is John F. Kennedy
      1. millionaire
      2. Harvard graduate
      3. Naval Officer
      4. Naval hero
      5. U.S. Sentor
      6. U.S. President
      7. Assassinated

   C. Exercise
      1. What do you notice as more information is added to each man?
      2. What information best describes the man?
      3. When drawing conclusions what must we be aware of?

VIII. Projects

1. Collect a series of words that fit various labels of speaking English i.e.
    1) slang
    2) formal
    3) vulgar
    4) standard
    5) jargon

2. Make a dictionary of teenage terminology.
3. Show instances where the use of the same word has caused trouble between two groups of individuals.
4. Have the class decide on a word which they want defined by people and make a list of the various definitions that people give.
5. Have the class go around to each of their subject teachers and ask them to define the word "test". The definitions will probably be different. 1) Why? 2) Can we ever resolve this difference of definitions between people?
6. If we can not arrive at similar definitions, what is the next best thing to do when we realize that their are differences.

Critical Thinking

I. Interdependence of the Senses - "Sense and Nonsense"

A. Sight - The eyes along cannot give us true knowledge.

1. Optical Illisions
2. Depth Perception
3. Binocular Vision
4. Show two objects that look alike but do not have similiar qualities.

B. Sound - Blindfold a student and produce sounds from different areas. In certain spots students cannot locate area of the sound.

C. Touch - Put similiar shaped objects in a cloth bag and have students try to identify the objects.

D. Smell - Blindfold a student and give him some objects to smell. It will be difficult to identify the object.

E. Taste - Blindfold a student and stop his sense of smell. Give him some foods to taste. After this allow him to taste the same food with the use of his olfactory sense. It becomes easier to taste with the sense of smell.

II, Black Box and Scientific Method

A. Construct a box with unidentified objects inside. Students must decide by investigation what these objects are. Such as:

1. Wooden cylinder
2. Ball with flat side
3. Pyramid
4. Metal cylinder
5. Two balls of different size and made of different materials

B. The Scientific Method

1. State Problem
2. Hypothesis
   a. Mere sight
   b. Previous knowledge
   c. Based on experience
3. Create a test procedure for objects using sight, sound, and touch in order to find out the following qualities of the unknown objects.

   a. size
   b. shape
   c. weight
   d. number
   e. composition
   f. texture

4. Interpret Data
5. Draw a Conclusion

C. Procedure:
1. Have students work first in their own groups.
2. After the students have worked on their own bring them together and collectively try to identify an object that the teacher has in a box.
3. Once the class has decided on a method of attack have them once again break into groups and attempt to identify the objects in their respective boxes.
4. Their are many different variations for this procedure. At some time the teacher should work with the class as a whole. The class should be conducted so that students identify objects using the inductive method.

III. Creating Scientific Games - In order to have students recognize creativity have them create games using basic learnings of science. Some examples of these type of games already in existence are: Ski-Ball, Pool, Shuffle Board, Pick-Up Sticks.

Listening Faults

I. Distractions

  A. Vocal Sounds

  B. Sources

  C. Elimination

Exercises

1. Play a record of a short story and at intervals cause some sort of distractions. What effect has this had on their attention and concentration?

2. Have a student talk about something he is interested in and let two students cause some minor distractions. Ask the students what the effect of these distractions are on: 1) the audience 2) the speaker

3. Divide students into groups and have them discuss a topic which they have an interest. Ask them to draw conclusions. At the conclusion show them that even though the classroom was noisy, they were able to do their work? Why?

4. Students watch a television show and report the plot. Point out that they know the plot despite the fact that there may be many as forty interruptions in the show. Why?

II. Daydreaming

  A. Wandering

  B. Note taking

  C. Questioning speaker

Exercise

1. Read a passage to the students without telling them why or even to pay attention. At the conclusion ask them questions about what was read. Investigate the source of daydreaming and how to overcome it.

III. Failure to See Major Issues

  A. Important points

  B. Minor details

  C. Emotional influences

Exercises

1. Have students discuss the idea that many times a word will have many different meanings to different people. (Similar exercise is done in Physics Unit.)

2. Have students discuss the idea that many times different words with nearly similar means convey a different atmosphere.

   For example:

   big-heavy-fat
   lovable-likeable-nice
   guts-bravery-backbone
   withdraw-retreat-run away

IV. Dull Subject

A. The speaker

B. The personality of listener

C. Difference between dull and interesting subject

Exercise

1. Have students tell jokes that they have heard other people tell. Does the class think the jokes are funny?

V. Failure to see the point of theanecdote or illustration.

A. Remember the story and miss the point

B. Listener not involved with the story

Exercise

1. Tell the class stories of famous people who in order to prove a point have told an anecdote. Have students try to see the meaning of their story.

For example:

At the conclusion of the Federal Constitutional Convention, Benjamin Franklin rose and said that all through the convention he had been drawn to the picture of the sun on the back of the presiding officer's chair. He did not know if it was rising or seeting. Now he knows it is rising.

Have the students try to understand the anecdote in the context of the convention.

English Correlation of Science Project

Testing for Properties of Matter

In order to reenforce and correlate the learnings in the Physics class, and the Physics Project, the English teacher will have the students do some research and make written reports and oral presentations on their projects, specifically for English class. The following questions will be answered for the English teacher.

Questions

I. Definition and Description

- A. Give a definition of your project.
- B. What is the purpose of the project?
- C. How does it achieve this purpose?
- D. What are the theories and principles behind the project?
- E. What materials are needed?
- F. Physically describe the project and how it works.

II. Industrial Concepts

- A. Is the project needed and used in industry?
- B. If it is needed and used in industry, how is it used and needed?
  If it is not needed and used in industry? Why not?
- C. What are some factors in the construction of this project? In school? In industry?
- D. Find out specifically what industry and company uses the project and arrange to visit and see the project operate.

III. Correlation and Problems

- A. In order to make this project what information was needed from outside the Physics class? i.e. Mathematics, Mechanical Drawing, Shop, English, or History.
- B. What information was drawn on from within the Physics class?
- C. What organizing procedure was used in putting the project together?
- D. What problems were encountered in the construction of the project?
- E. What has been learned by attempting this project.

Discussion Questions

Fahrenheit 451

1. What is the significance of the term Fahrenheit 451?
2. What are three symbols of Montag's job?
3. How does Clarisse McClellan provide a catalyst for Montag's life?
4. How does the Mechanical Hound kill?
5. What is the purpose of the Mechanical Hound?
6. Why does Fun Park exist?
7. What is the significance of the grille in Montag's house?
8. What role does Montag's Captain play in the book?
9. For what reasons are historical events changed by the government?
10. What is the importance of Clarisse McClellan's disappearance?
11. What Role does Faber play?
12. Why does he design a "green bullet for Montag?
13. Why is Montag's house his last fire?
14. Who turned in the alarm on Montag? Why?
15. Why is the Captain destroyed?
16. Why do the police show Montag's capture on television?
17. Where does Montag eventually find refuge?
18. Is it appropriate that the city is destroyed?
19. What forms of alienation are present in the novel?
20. What is realisitc and unrealistic about the novel?

Science Fiction Reading List

Fahrenheit 451-- by Ray Bradbury

The Warof the Worlds --by H.G. Wells

Junior Year

Industrial Prep English
Unit Four

Economics

I. Credit

II. Installment Buying - Buy Now - Pay Later

III. Borrowing Money

IV. *Motor Trend* Magazine - June, 1966 - Vol.18, No.6

Used Car Buyer's Guide
  A. Hottest Cars on the Lot
  B. Depreciation Works Two Ways
  C. How To Spot a Lemon
  D. Spot Troubles Electronically
  E. Can You Really Fool a Salesman?
  F. Financing and Insurance Tips and Traps
  G. Used Car Check List

V. Questions on Car Articles

VI. Projects

ECONOMICS UNIT-Consumer Credit

Credit

I. Producer Credit-The producer borrows money to make money.

  A. For equipment
  B. To meet peak demands
  C. To make up a deficit

II. Consumer Credit- Debts for goods and services for personal and family use that mature within five years or less.

  A. Convenience-gas and electric-milk-paper-retail stores.

  B. Acquire Goods-to improve a way of life.

  C. To pay debts-hard luck

III. Types of Consumer Credit

  A. Charge Account

    1. promise to pay
    2. usually 30 days
    3. gentleman's agreement

  B. Revolving Credit

    1. maximum amount at one time
    2. a payment per month
    3. service charge

  C. Credit Cards

    1. identifies customer and permits charge.
    2. department stores, oil companies, air lines.

IV. Advantages of Cash

  A. Go anywhere to buy
  B. Save credit charges
  C. May get discounts for cash
  D. Do not overbuy
  E. Safety margin
  F. No debt

V. Advantages of Credit
  A. Establish credit
  B. Convenient
  C. Better Service
  D. Not limited by cash
  E. Buy now and enjoy

V. Opening a Charge Account

- A. By Mail
- B. Charge Plate
- C. Application
  - 1. name
  - 2. address
  - 3. employer
  - 4. job
  - 5. how long at present job
  - 6. bank
  - 7. references

VI. Credit Bureau

- A. Data on credit applicants
- B. Receive reports on people's credit
- C. Stores can check on credit rating

VII. 3C's of Credit

- A. Capital Worth
- B. Capacity Earning
- C. Character Obligations

VIII. Merchant's Problems

- A. May offend
- B. May miss sale
- C. Returns on Credit

IX. Films for Unit

- A. Credit Man's Confidence in Man
- B. What Makes Us Tick
- C. Credit and Loans
- D. Personal Money Management

Installment Buying - Buy-Now—Pay-Later

I. How it Operates

- A. Special charge added to price of goods
- B. Formal Contract
  - 1. Down payment
  - 2. Weekly or monthly payment
  - 3. Seller owns title to goods
  - 4. Payments spread over long period of time

II. Cost - For use of goods, a fair price is payed.

- A. To seller
  - 1. Interest - money is tied-up by consumer
  - 2. Bad risks
  - 3. Administrative costs
- B. To Consumer
  - 1. True rates
    - a. Unpaid balance

When they say	You pay
½ of 1% per month	6%
3/4 of 1% per month	9%
1% per month	12%
1¼% per month	15%
1¼% per month	18%
2% per month	24%

- b. Certain percentage per year

When they say	You pay
4%	7.4%
6%	11.1%
8%	14.8%
10%	18.5%
1% per month	22.2%

III. Is Installment Credit Worth The Cost?

- A. Advantages
  - 1. Using the goods while paying for them
  - 2. Raises standard-of-living
  - 3. Encourages saving through the contract
  - 4. Helps people get a start
- B. Disadvantages
  - 1. Always pay more than price of goods
  - 2. Can overbuy
  - 3. Reduces margin of safety
  - 4. Destroys thrift habits
  - 5. Worries and tensions

IV. Guides

A. Goods which are most suitable to time purchases

1. Any investment to increase income, i.e. a salesman's car.
2. Lasting permanent value that improves family's standard of living and lasts long after the last payment charge, i.e. a new living room set.
3. Necessities rather than luxuries, i.e. a refrigerator.
4. High price articles rather than lower price articles, i.e. color television set as opposed to a portable radio.

B. Contract - Conditioned Sales Contract

1. Title does not pass to buyer until final payment is made.
2. Destruction of property does not release purchaser from his obligation.
3. If the buyer is in default the full amount comes due immediately and repossession may be expected with or without notice.
4. Seller may charge expenses of repossession.
5. Seller may take any article that is part of the property covered by the original contract, i.e., radio in a car.

C. Penalties for Non-payment

1. Wage assignment
    - a. appears in contract
    - b. may be from 10% to 25% of salary
    - c. employer is notified that the wages of delinquent debtor be paid to the creditor.
    - d. employers frown on this procedure.
2. Garnishment
    - a. Court orders employer to pay salary of employee's to creditor
    - b. A portion of employees wages.

D. Rules to Observe

1. Make a substantial down payment.
2. Pay the balance as quickly as possible.

BORROWING MONEY

I. Where to Obtain Loans

A. Commercial Banks, Savings Banks, Savings and Loans Associations

1. First stop-
2. Loan departments
3. Passbook loans
   a. short time
   b. low interest rate

4. Methods of giving loan - fair rates
   a. discounting
   b. add-on
   c. unpaid balance

B. Credit Unions

1. Credit to members
2. Low rates - Usually certain percentage of unpaid balance.

C. Consumer Finance Companies

1. More expensive than banks and credit unions
2. Small loans
3. Credit risks
4. Regulated by state laws

D. Insurance Companies

1. Cash surrender of insurance policies
2. Low rates
3. Reduces value of policy

E. Pawnshops

1. Leave collateral which can be sold after a set period of time
2. High rates

F. Unlicensed Lenders (Loan Sharks)

1. Extremely high rates - i.e. 20% per month or 6 for 5
2. Desperation

II. Advice
A. Shop for credit
B. Value of loan to borrower
C. Ability to pay back loan
D. Reasonable cost
E. Honest Lender
F. Establish credit

III. Credit rating

A. Name is listed
B. Be frank with lender if payments are allowed to fall behind

MOTOR TREND - June 1966 - Vol. 18, No. 6

HOTTEST CARS ON THE LOT

" In the end, it's the one that pleases YOU the most."

Most used-car buyers venture with some trepidation into the marketplace, not quite sure of themselves, or the car they might fall in love with, or the man with whom they have to deal. For any combination of these reasons, they seek a source of supply that they feel will give them the greatest sense of trust--and for the most part, this turns out to be the used-car lot of the friendly neighborhood new-car dealer.

The logic behind this self-reassurance is natural: The new-car dealer has a franchise and reputation to protect; he has factory-trained service personnel, modern test equipment, authorized replacement parts; he keeps only the better used cars for resale and has a larger selection in his own franchised make.

With the continuing boom in new-car sales, and the resulting flood of trade-ins, the dealer has to keep his finger on the pulse of the used-car market. While his experience may reflect only local conditions, polling a number of new-car dealers could collectively reveal prevailing trends and attitudes of importance to used-car buyers.

And so MOTOR TREND surveyed 50 of the nation's top-volume retail used-car dealers, asking questions that would disclose the thinking on their side of the desk. Here are their answers on a number of important subjects...

THE MOST POPULAR CAR?

The significance of the designation "hottest seller on the lot" has changed in recent years. In the past--and this still applies--the best seller was not necessarily the best buy. Since demand usually exceeded supply, a premium "overbook" price could be asked and obtained if the buyer really wanted to own a model that was "in" at the moment. But times--and tastes--change, and quite often today's hot bird becomes tomorrow's cold turkey. Only a few models--led by Chevy's seemingly legendary Impala hardtop--have apparently been blessed with eternal popularity.

The general picture, however, may be changing. There are now many more series and models contending for "hottest seller" honors. Manufacturer advertising has stressed both "the sizzle and the steak," and emotional favoritism for certain makes and models threatens to run wild in numerous directions simultaneously.

As would be expected, the reported current hot sellers on the respective lots are of the make the new-car dealer sells. This reflects not only brand-name loyalty on the parts of owners, but also the dealer's desire to trade, service, stock and sell used cars which may, in the near future, turn their buyers into the new-car purchasers (hopefully of the franchise brand, and from the dealer's own showroom).

Dealer selections of hottest sellers ranged widely, depending on the section of the country and even the immediate community. Judging by listed order, 2-door hardtops and coupes seem more popular with Chevy buyers, while 4-door models are the more frequent choice of used Chrysler shoppers. A number of dealers listed "all" or "any" for customer preference in series or body styles, indicating that some buyers are just looking for a certain make.

It's difficult - with so many subjective and market factors involved - to arbitrarily pick the hottest sellers on any basis that could be applied nationally, or even regionally, or to any specific make. A dealer in St. Petersburg, Fla. for example, reports a recent local "run" on "57 Chevy Bel Air coupes.

In most instances, when cars become available for second owners, used-car popularity is related to new-car sales of two or three years previously. The average age of the dealers' first choice for the hottest sellers is two years old (1964 models). This finding indicates the increasing importance of one consideration when it comes to buying and selling a used car - and that is the original manufacturer's warranty...

ANY WARRANTY LEFT?

A 2-year-old used car with an original 24-month 24,000-mile warranty would no longer be covered by the manufacturer, and one of the major used-car warranty plans - or the dealer's own - would have to be applied. The value of a longer-term original warranty was summed up by a Chrysler- Plymouth dealer in Miami, Fla:

"The greatest thing to happen to the automobile used-car industry has been Chrysler's 5-year/50,000-mile warranty which is transferable to the second and third owners or more. One of the first questions a prospective buyer asks when he walks onto our used-car lot today is whether the car is covered by the 5/50 warranty, and if it is, this car will bring approximately $200 more retail and about $100 more wholesale."

Acknowledging this value of the remaining balance of a long-term warranty in used-car selling, Ford has announced a regional test of a new warranty plan in connection with its A-1 used-car program. Ford dealers will offer buyers of 1963-65 Ford, Mustang, Fairlane, Falcon and Thunderbird cars a warranty extending two years from the date of used-car resale, or five years from the date of production, or 50,000 miles. The warranty covers the power-train components on a $25 deductible basis.

If this trend is followed by other 24/24 warranty manufacturers, then this feature will become a desired one by used-car buyers and may have to be considered in "book" evaluation. As one dealer pointed out, "The value of a car still under original warranty is not truly reflected by the 'book' values."

For the present, the used-car warranty generally follows the dealer's franchise program - Chevrolet's "OK" and Ford's "A-1" (both 50% discount on parts/ labor for the first 30 days and 15% discount for the next 24 months); American Motors' two Select Used Car plans for Rambler and non-Rambler vehicles; and Lincoln-Mercury's Gold and Silver Crest warranties. Perhaps the most prevalent warranty on used cars is the Guaranteed Warranty (GW) which provides a 15% discount for one year on parts and labor.

There are, however, a great variety and combination of warranties offered by individual dealers, depending on the competition and the dealer's own faith in his reconditioning program.

DO ACCESSORIES HELP SELL?

Almost universally regarded as "desirable" are radio,. heater, V-8, and automatic transmission - with four-on-the-floor having increasing appeal for the performance-minded.

Of the dealers surveyed, 93% indicated that power steering is a definite plus, but only 45% felt that power brakes and/ or tinted glass would help in selling the car. As would be expected, tinted glass was checked as desirable by more of the dealers in high-sunshine areas.

On heavier vehicles, it was felt that power brakes should be on the list, and on larger, more expensive cars - or those to be used in intemperate climates - air conditioning approaches the "must" category.

In general, comfort/ convenience accessories are being ordered in increasing volume on new cars, and consequently show up on more used cars. Even though there is a sliding scale of depreciation loss on accessories, they still are a desirable feature- whether you're selling or buying.

MILEAGE - HOW IMPORTANT?

We asked the dealers, "Is a low-mileage, average car more saleable than a relatively high-mileage 'cream-puff'?" By tabulation, they favored the lower-mileage vehicle by almost three-to-one. If you're planning on trading your car, try to keep it in tip-top condition, with no more than the national mileage average of 12,000 for each year...and hope that the owner of the car you'd like to buy has been able to do the same.

WHAT'S YOUR TRADE?

If you have a resaleable trade-in, the dealer may warm up his welcome, because that gives him another car to sell at a profit. If you've come to shop without a swap, don't worry - you'll be surprised at what the dealer may accept in trade. Apparently few deals are turned down, judging by the following list of items the dealers reported considering or accepting in trade:

Hi-fi set, vacant lot, motorcycle, gun collection, mining stock, tow truck, welding helmet, electric train set ("with lots of extra buildings"), bulldozer, 4-bedroom house, hearse, animals (horses, cows, pigs, monkeys), boat, airplane, 5-karat diamond ring (worth $8000), a '65 Rolls-Royce (on a '65 Plymouth wagon), and "a 24-year-old blonde girl - a beauty!"(no indication given whether the deal was made).

Summing it all up, a Rambler dealer in Pittsburgh, Pa., reveals both sides of the coin at once: "Remember, the used car business is the money in any new-car deal. You haven't made a dime until you've sold that used car. And ths used-car buyer is eventually a new-car buyer - so you must keep this in mind always."

--Erv Rosen

MOTOR TREND - June 1966 - Vol. 18, No. 6

DEPRECIATION WORKS TWO WAYS!

"It all depend on the car you want, and how long you'll keep it."

Depreciation is your biggest single expense of car ownership, whether you buy new or used. In the purchase of a new car, Blue Book figures coldly show that with Car A, you can drive out of the dealership, keep it from one to six months and then sell it for almost what you paid for it. With Car B, the act of taking delivery, per se, can cost you $1000 or more.

Specifically, let's assume that today you purchased a new Lincoln Continental 2-door hardtop at the f.o.b. price of $5647. According to the Western Edition (March-April) of the authoritative Kelley Blue Book, you could turn around and sell it for $5745. On the other hand, try the same trick with and Imperial LeBaron at $6706. The minute you sign your check, it is then worth a top of $5865. Thus you see that in the case of a hot, scarce new model, you theoretically would turn a modest profit and with the other equally good but less popular car, your immediate loss is a whopping $841.

Now, let's turn to two more logical used-car purchases. Take a 1964 Buick LeSabre 4-door, which cost $3367 new. Blue Book figures show that it's worth $2060 now at retail. An equivalent 1964 Mercury Montclair costing $3396 new sells used for a maximum of $1595. Which is the better buy?

The answer is simple only if you plan to either trade again in a year or less or, conversely, keep the car indefinitely. Once the depreciation pattern for a given make and model is fixed (usually within a few months after its introduction), it holds for all practical purposes up to the point where an aged cream-puff of any kind is always worth a quick $300-$400. Thus you see that if you want to trade frequently, you best buy is the car that depreciates the least, but if you keep the car for an extended period, choose the model with the high rate of depreciation. There is a difference in the example above of a cool $465 for equivalent transportation. In another four years, both of these cars will be worth the same token amount--if they are in good condition.

Any home economist will tell you that you should consider your car, used or new, a liquid asset, because an emergency may require its quick sale. This bit of logic weighs heavily in favor of paying more initially for the car that depreciates the least.

Let's also be realistic and assume that you are making a minimum down payment, which may be but 10% or less in many areas. Once you have signed the papers and started the payments, the slow mover likely will depreciate, at least for the first year, faster than the rate at which you are paying for it. Thus, in an emergency, the car would be a liability rather than an asset. Also, the finance companies are well aware of this added risk and charge interest accordingly.

However, it ia a galling thought to feel that you should always govern your reactions by the rule book. Emergencies are rare, and even so, what economist could argue against the logic of a person with $2000 to spend buying a $1500 equivalent car and banking the savings?

In this situation, if the styling or some other intangible that draws you to the Buick LeSabre is worth $465--by all means, buy it. But if you think the '64 Merc is better-looking (and you are also drawn to it because Darel Dieringer thinks this is the best race car around), then buy the so-called "dog" and take a fine vacation on the savings. Given equal conditions, both cars are equal in comfort, performance and durability.

Our conclusion is simply this: Buy the "hot car" if you want to trade every year, or if you want to stay protected financially every month. Buy the "dog" if your initial thoughts are to keep it indefinitely. If you can't make up you mind, play the quinella.

--Don MacDonald

MOTOR TREND - June 1966 - Vol. 18, No. 6

HOW TO SPOT A LEMON

"You bring sharp eyes and good ears, and we'll show you..."

There is probably no greater bargain on earth than the best used car $2000 will buy. But it has to be the "best"! Anything less leads by degrees to a financially distressing headache known in trade parlance as a lemon.

Unlike the fruit, you can't just toss a little sugar into a bum car to make it sweet--sugar, in this instance, being money. If you are buying a new car, there is nothing you can do to protect yourself against the one-in-50,000 chance of getting a lemon. When buying a used car, though, there very definitely is.

Of primary importance is your choice of dealer. He may or may not be an authorized new-car dealer as well, but the odds do favor you if you patronize the man whose primary business is to sell new cars. The reason is simply that he looks upon his used-car lot as a stepping-stone for customers who may one day buy new cars from him.

If for no other reason than avarice, this type of dealer is sincerely concerned that nothing but good used cars appear on his lot. He will wholesale trade-ins that are either too costly or impossible to recondition, and he is much more likely to stand behind his merchandise despite the wording of the warranty, if any, offered.

You saw on page 28 that the hottest car on any lot was invariably a used model of the make the dealer sells new. Enough people, apparently, realize that the logical place to purchase, say, a used Dodge is at a Dodge dealership. If the original owner of the used car was happy with it, he is likely to trade it in on a new one of the same make so chances are, by matching dealer and make, you will be buying a used car with a record of satisfactory performance. Also, you can have it intelligently serviced where you bought it.

None of this means that you should arbitrarily bypass the used-car operation not connected with a dealership. In small towns, especially, the owner may be a paragon of virture and quite astute in his selection of merchandise for resale.

However, aside from cars acquired from private individuals, his only sources of supply are those channels used by new-car dealers to dispose of their unwanted vehicles. Some good cars are wholesaled or auctioned when a new-car dealer is overstocked in a particular model or needs to raise cash--but remember that also down this path travels every lemon in search of a new sucker.

There is no particular set of secrets that distinguishes a quality dealer from the marginal operator. Look first at his ads. Does he emphasize quality and reputation, or the claim that he undersells everybody? Are his TV and radio commercials blaringly hard sell, or do they give you the impression that here is fine merchandise at a fair price? A quality dealer treasures his reputation because it is money in the bank, and thus he has little real need to employ expensive sales gimmicks to attract customers.

After picking a few promising sources for your used car, travel to the dealerships and look at their facilities before bothering with the merchandise. Ask the dealer to show you the reconditioning operation. If he has one worthy of the name, a number of cars will be in process at all times and you can easily see if the procedures involve just a lick and a polish, or if essential repairs are actually being made.

Look, also, for trucks being serviced. A sure sign of a good repair shop, and thus a good dealership, is when the owner of a truck picks that place for his service needs. Down-time on a truck often costs more than the repairs.

The caliber of the salesmen you encounter is a less tangible but equally important clue. It will soon be apparent whether he wants to help you select, or do the selecting for you. Spot a car with a defect, and see if he volunteers a warning. A good salesman and a good place to buy go together, and most of the better dealers no longer have a place for employees of the straw hat, cigar and fancy vest school.

After a wise choice of dealership, you can relax your guard a little, for the odds are now against merchandise with known defects being offered for sale except in "as is" condition. There still, though, is the very real possibility that something may have slipped past the dealer's own conscientious inspection. Also, by no means do a majority of new-car dealers perform anything that even approaches a thorough reconditioning procedure.

On the pages that follow, we show you how to guard against the lemon or, conversely, to spot the cream-puff. This guide, and the check list on [illegible] [illegible], is designed to work for you even if you ignore our earlier advice and choose to deal with a swarthy broker in used camels.

You're on your own, though, if you're interested in a car belonging to a close friend or your boss. Any one of the 15,000 or so parts in the car stands fiendishly ready to break up the friendship, or, if you pursue your "rights under warranty," to cost you your job.

Exterior

"Mechanics' Special" might be a valid term to describe a used car that has assorted internals ills, and is priced accordingly, but no reasonable amount of money can properly correct extensive body deficiencies.

No car is ever quite the same after the repair of serious accident damage. Whole panels may be replaced, but the attendant welding impairs the efficiency of the original factory rust-proofing. Also, the repainted sections will soon show evidence of the transplant by fading. Even a simple bumped-out fender presents an Achilles' heel, because the corrosion-resistant primer is destroyed in the process.

In a majority of areas, all cars are subjected to attack by corrosive snow and ice-removal chemicals. Seacoast areas, particularly in the semi-tropics, are equally deleterious, and so too are the solutions commonly used to settle dust on dirt roads. If there is evidence of rust on any major body panel, do not pay serious money for the car. Rust normally works its way from the inside to the out, and can only be temporarily halted.

Even in Detroit, the center of corrosion as well as the auto industry, it is possible to buy used cars that are healthy, but this is because their owners washed them with vigor immediately after every excursion upon salt-laden streets. Since a nut such as this is uncommon anywhere, much less in the city that bred the myth of trading-in every year, a technique of hiding rust cancer with plastics developed. We say "hiding," because this does not constitute a permanent repair..

Fortunately, such a plastic inlay may be detected by a simple dime-store magnet. Get one and check the entire area of the rocker panels, and that part of the fender immediately above and below the headlight bezels. Also run the magnet down the front fenders on a line parallel and adjacent to the front doors, as well as around the tail-light bezels.

Detection of bumped-out body panels requires only a sunny afternoon and possible a pair of sun glasses. Squint along the sides of the car against the sun, and you will spot the inevitable unevenness of a hand-hammered panel. On panel replacements, you will have to look for evidence of welding and repainting. If one door carries its usual quota of parking nicks and the other does not, be on your guard. There will be evidence of over-spray from the repaint on areas that the painter thinks won't show.

Guard particularly against any car less than four years old that shows evidence of being entirely repainted. The trick here is to remember that at the factory, every piece of chrome was put on after the car was painted. Perhaps fortunately for you, the average body repairman is lazy enough to skip masking the rather complicated trade-name scrolls.

The exterior presents two other good points for inspection. Lift the hood and study the bolts attaching the grille. If they seem newer than the rest of the hidden parts, you might be looking at a refugee from one of those expressway pile-ups. Then look at the alignment of the headlamp housings. This is one of the hardest areas of all for bodymen to restore to original factory configuration.

Lastly, as preparation for your look at the interior, check the play in the driver's outside door handle. If it's floppy, that 20,000-mile car either was used as a Chicken Delight delivery wagon, or the odometer reads 30,000 miles on the optimistic side.

Interior

Except on Chrysler products with their transferable 5/50 guarantee, you might as well assume that the odometer mileage showing on a used car is meaningless. The problem is pinpointed in our national dealer survey [illegible]: Customers illogically prefer an "average" low-mileage car to a relatively high-mileage cream-puff.

Thus, even the most honest dealers tend to take the easy way out and spin the odometer back to where it shows no more than 10,000 miles per year of car age. Cadillac dealers long ago adopted the argument-settling procedure of spinning back the mileage on used Cadillacs to zero, but only on those that have been thoroughly reconditioned.

Better than the odometer as a mileage indicator is, surprisingly enough, the windshield. Glass is softer than you think, and wipers over a period of time leave their marks. Sight through the glass into the sun, and if you see the tracing of the wiper arc, you are looking at a 50,000-mile car in areas of average rainfall. Then check the window regulator in the left-front door. If it's floppy, you can confirm high mileage.

The condition of the driver's arm rest doesn't mean much, because this is a commonly replaced part, as are the pedals and floormat. Often overlooked by the dealer, though, are the grease stickers, and neither surprised nor discouraged if they show service performed at a mileage higher than that totaled on the odometer. Make a note of the service station involved. They may remember the car and be able to give you some first-hand information about it.

You won't encounter too many late-model used cars with seat covers, and when you do, be suspicious. Some people still install covers on their new car, but it's still worth the trouble to unsnap the front-seat cover and inspect the original upholstery underneath. A cover could be used to cover flood damage or a worn seat.

Also be suspicious of upholstery panels that are obviously fresher and cleaner than the rest of the interior, as here again may be evidence of flood or fire damage. Look, too, at the rear package shelf. Unlike the covering now used for padded dashboards, the coated paper material often used behind the rear seat fades and cracks rapidly when the car is consistently parked outdoors.

We've saved mention of convertible tops for this section, because wear and evidence of leakage first show from the inside. By all means operate the top, as repairs to this mechanism are expensive. If you're looking at a station wagon, remember that the covering in the cargo area is designed for normal wear and tear, but not necessarily usage, as is the trunk in a sedan. Now to the chassis...

Power-train

With the car still on the grease rack, preferably the kind that allows free wheel motion, check for excessive oil accumulation under the engine, transmission and differential. A neglected, serious leak from either of the first two mechanisms will soon bathe the whole underside of the car with oil.

This could be caused by such minor matters as an ill-fitting drain plug or leakage in a simple seal, but remember that the 10¢ seal might require four hours' labor to replace. A heavy accumulation of condensed oil around the blow-by tube is a sure sign of a badly worn engine.

Grasp the driveshaft and wiggle it. Excessive play indicates worn universal joints. This is a relatively minor problem, but there is still no point in your paying for its correction. Rotate each rear wheel separately, with your ear to the centerpoint of the hub. A faint grinding noise will tell tales on a worn rear-axle bearing, and these run about $20 each to replace on the average car.

Now, get someone to turn either wheel for you while you listen to the differential, using a screwdriver or other metallic tool as a kind of stethoscope. Any heavy grinding noise, steady or intermittent, means expensive trouble with the rings and/or pinion gears or their bearings.

If the car doesn't pass these tests, bring it down from the grease rack and forget it. If it does, bring it down anyway and lift the hood. You may or may not be greeted by an engine that looks like new, because many dealers now make it a practice to steam-clean and paint this area. This does not, however, necessarily mean that he has made needed repairs. This type of dressing up also makes it difficult to spot such evidence of a collision as a new radiator.

There is only one way to adequately check an engine. Pay a mechanic to remove all the plugs and at cranking speed and full throttle, check the compression in each cylinder. A car like a Ford Falcon 6 should produce a reading of about 125 psi, and the more powerful V-8s may read 150 psi or higher.

The important thing is that these readings be relatively even. A low reading in one or more cylinders means serious mechanical trouble. At the same time, visually check the engine and its accessories. Batteries, hoses and belts about to fail look their age. Check the oil. Black oil, if not too thick, is normal; gray oil indicates the presence of gasoline in the crankcase. Now start the engine....

Road testing

Most people drive a used car at least around the block before they make a decision to buy, but this is not what we mean by a road test. Neither do we expect a dealer who does not know you to loan you the car for the weekend.

Bring the salesman along if he insists--or even better, your own mechanic--and drive the car for at least 15 minutes. When you first start it, watch for exhaust smoke. Don't worry about black smoke, which just indicates an overly rich mixture, but be leery of a car that sends out a cloud of whitish-blue fumes, as this is a symptomatic of an oil-burner.

Check the oil-pressure indicator if the car is so equipped. The needle should not be sluggish in rising (or the warning light in going out), as this could indicate either a very dirty engine or poor bearings. A further check on the bearings comes if the oil pressure significantly drops after the engine is thoroughly warmed up.

As you move off the lot, watch the temperature guage which, if the thermostat is working properly, should soon indicate an increase. Here is a good time to check the heater even if it is summer.

If conditions permit, give the brakes a good workout at the first stop light. Does the car swerve, or do you hear the metallic squeal caused by linings worn down to the rivets? Put in a little mileage on a freeway to see if the car tracks well without excessive correction, and if the wheels are properly balanced.

Next, pick the roughest road you can find and hit it hard. Does the suspension bottom, or is there excessive rebound? This is just shock absorbers, but they are expensive. How about rattles--not just an isolated one, but does it sound like the whole body is in motion? Do you get shock back through the steering wheel, indicating worn bushings?

All the time you are driving, test accessories such as the air conditioner (if any), radio, power assists and even the cigarette lighter. By now the engine, transmission and rear axle should be thoroughly warmed. Do any unusual noises come from these? A whining axle is $100 worth of trouble, and so are noisy valves.

Now you can reach for your checkbook with reasonable safety, but you still may want to take the car to a car clinic, as we did on the following page.

MOTOR TREND - June 1966 - Vol. 18, No. 6

SPOT TROUBLES ELECTRONICALLY

In this "computerized" age, we're all a bit prone to believe man-made machines more than men. This accounts for the tremendous success of electronic diagnosis centers now in operation around the country by Mobil Oil, Ford Motors, Shell Oil, Humble Oil, and Goodyear Tire and Rubber.

Highly refined and expensive equipment is used, as well as men experienced in automotive repair, to check out cars brought in for diagnosis. The response to these centers has been so good that most now have a waiting list, and appointments must sometimes be made two to three weeks in advance.

Mobile Oil Co. is one of the pioneers in electronic diagnosis, so we visited their nearby facility in West Covina, with a car borrowed from the used-car lot of Harger-Haldeman in Los Angeles.

Though not a great deal was found wrong with our test car, nothing was overlooked. With the car up on the rack, the underbody, front end, rear end, drive line, steering gear and box, shocks, ball joints, tires, crossmembers--just everything--was scrutinized for damage and/or wear. Two "diagnosticians" checked and rechecked the entire underside. Back on the floor, the brakes--their balance and lining remaining--were inspected.

After the maze of test equipment was hooked up, the engine was put under load conditions by spinning the wheels on a dyno. This also enables the testers to observe transmission slippage and speedometer error as well as the fuel consumption, horsepower, ignition, and performance of the engine at varied rpm. The test is completed by spinning the front wheels on a dyno to check the alignment of the front end. Headlights, tail lights, and the entire electrical system get a going-over, too.

Almost all diagnostic centers have a repair facility which, because of the minimal profit derived from the analysis, is the backbone of their business. The customer, though, is under no obligation to have his car fixed there. He is given a copy of the diagnosis check-off sheet for reference by his own mechanic, if desired.

In the case of a prospective car buyer (when and if he can get a convenient appointment), the list of faults to be corrected could be used as a bargaining point to get the price reduced. Used car, new car, your own car--in any case, the days of having to make educated guesses at car problems are almost at an end. -- Steve Kelly

MOTOR TREND - June 1966 - Vol.18 No. 6

CAN YOU REALLY FOOL A SALESMAN?

It has been said that lantern-carrying Diogenes was engaged in a fruitless search for an honest used-car salesman. For this annual Used-Car Issue, it was suggested by former used-car salesman, Ferris Hough, that we take a close, hard look at the honesty of the used-car buyer. To Hough's own experiences, we have added the observations of other used-car salesmen whom we interviewed on this controversial subject. The resulting article holds up a mirror to the used-car buying public's conscience--and may cause many heads (including yours?) to be hung in shame.--Editor

It was my "UP" on the south side of the used-car lot. A spotless "cream-puff" Buick eased up to the curb. A little old lady slid daintily out from behind the polished steering wheel. She gently closed the door and stepping back, flicked a speck of dust off the fender with her handkerchief. The car had obviously enjoyed ten California winters. The odometer read a measly 37,693. I was ready!

Little old Mrs. Foster was somebody's beloved grandmother. She was a respectable, retired school teacher, and was ready to trade her old but immaculate automobile in on a new Buick. I had 47 new ones on the north lot, and a good market for her old car.

I waited for her to begin the conversation, not wanting to appear too eager. She did --and within the next two hours this innocent little "shyster" had lied, connived, misrepresented, brow-beaten, and attempted to cheat me in ways beyond my wildest imagination.

This was my introduction to the business of selling automobiles in an average American city. I was to learn that Mrs. Foster's Buick had a bad transmission, a ruined radiator, completely worn-out brake linings and wheel cylinders, and that the original odometer had broken and had actually read 67,437 when it was replaced the previous week with the one that was set to read 37,693.

I got the message loud and clear! Perhaps everyone pulls a little shady deal once in a while, but when people walk into an automobile agency, they turn into sadistic monsters. Primitive desires of cunning and craftiness grip their emotions, their palms get damp with sweat, breath comes more rapidly and they smile with sinister anticipation. "Cheat him before he cheats me" is their basic motivation.

People who are basically honest in every other area of their daily living will almost sell their soul to the devil to get the best of a car salesman. The auto sales business people have probably brought this on themselves in the past, but the caliber of car salesmen has improved in recent years --just as professional competence has increased in most other fields, selling or otherwise. Every car dealer, both new and used, would really like to bring auto selling up to a higher plane of intelligence and integrity, and is trying to whenever possible. This vicious credo of "cheat him before he cheats me" has got to go.

Many articles have been written on how to avoid being cheated by a car salesman. Some blunt things have to be said about how to avoid being a cheat yourself. Everyone would benefit if the entire car transaction business were to be upgraded.

There are any number of ways to cheat or lie to a used-car salesman in trying to get a better deal. One of the most common is to ask, "How much for this car, without a trade?" Often, depending on the market at the particular time, the price will be lower. Then the "innocent cheat" will spring his trade-in on the dealer. He'll want full market value for his car --and the "no-trade" price for the dealer's car. When he can't get it, he's unhappy.

By this time, the dealer knows he has a "cheat" on his hands and usually isn't going to go out of his way to do any further "dealing" with him. Customers themselves would become inflamed if something as low as this were pulled on them, but they seem to think it's perfectly all right to use such a tactic against a car dealer.

Car dealers are legitimate businessmen. They have to do a certain volume of business and make a reasonable amount of profit in order to keep operating. Profit from the sale of a car can be much less than some may realize, by the time a dealer gets through adding up salesman's commission, reconditioning, and the rent-value space taken up by the car while it's waiting to be sold. If you insist on a "long" (high) price for your trade, it only means that the car dealer has to hold the price up on the car you're trying to buy.

It is ridiculous to believe that your used car is worth more if you trade it in on a luxury or high-priced used car or a new car. Worth more to whom? The dealer has had to spend more to get a car that is worth more, just as you would. He may have slightly more profit with which to dicker on his car, but your trade-in still has an actual value relative only to what the dealer can get when he sells it.

An over-allowance on your trade turns out to be just so much hocus-pocus and just means that you'll not get a reduction in price on the dealer's car. The actual price difference between your car and his is the only important financial consideration. Taking less for yours, and buying his for less, will save you money, especially if you're financing it.

In the long run, misrepresenting your car won't gain anything for you if you're trying to get a higher trade-in price for it. Car dealers are experts in appraising the true value of automobiles, even though they're waxed and highly polished. Very rarely is a used car worth more than the wholesale price listing. The dealer may have to spend sizable amounts in reconditioning your old car if he plans on reselling it himself, so very often it is worth much less than the wholesale figure.

Don't be blind by unrealistic sentimental attachments to the old buggy. If it's as good as you insist it is, the dealer can't help but wonder why you want to trade it in.

Don't waste several hours of a salesman's time before you're ready to buy. Most salesmen work on straight commission, with no definite salary, so their time is very valuable to them. They don't mind competing --it's a way of life with them -- and they don't feel too badly in losing a deal if a customer plays fair with them. However, taking several hours of a salesman's time on the pretense of immediate purchase, when you have no intention of buying for quite a while, is like stealing right out of his pockets. You may suffer consequences, should you return at a later date and expect a "friendly" price from this same salesman.

There is one type of "cheat" who is particularly at odds with most car dealers. He's the guy who wants immediate delivery on a car, especially on week-ends. Most dealers are reluctant to deal with this type, as it can be a matter of bad credit. This isn't always the case, but dealers logically figure that if the customer can't wait until the following business day, there may be some hidden factor.

When the man is looking at a car which has been stagnant on a lot, the dealer is really torn as to what to do. The customer may be perfectly reputable and the dealer could lose a good chance of selling the car by refusing immediate delivery; or on the other hand, by the time the customer's credit can be thoroughly checked and he's found to be a bad risk, the car may be halfway into the next state, with the chances of seeing it again very slim.

Do yourself a favor: Don't push for "Saturday night" delivery with the thought that you'll get a good price because the dealer fears he'll lose the sale. He may be forced to add a little to the price, charge a higher rate of interest, or allow you less on your trade in order to cover himself in case of loss. You'll wind up cheating only yourself in this case.

When buying a used car, be intelligent enough to realize that in any investment there is a calculated risk. Find out as much as possible about the condition of the car under consideration, and if possible, have your mechanic check it over. You should recognize that there may be things wrong with the car which no human being can detect.

Be sure to have the dealer explain carefully what is covered in the guarantee and have a written copy of it. Know what you'll have to fix and what he'll have to fix. If the car should break down after you buy it, be aware that he is going to fix only what he agreed to at the time of the purchase. Any insistence on your part that he repair more than he agreed to will more than likely only get his dander up and cause you more trouble than it's worth. After all, he sold you a used car--not a new one.

When you first ask the price of a particular car, two things happen. The salesman assumes that you'll immediately try to get him to reduce the price as much as possible. This he has come to believe after many years of contact with car buyers.

On the other hand, you assume that he will quote you the inflated price, so you won't believe him, no matter what the initial figure is. I have sometimes experimented with human nature, for my own amusement, by quoting a price several hundred dollars under actual cost. Invariably, without batting an eye, the prospective buyer will immediately begin chiseling. This is obviously unnecessary child's play. It's not important who starts this vicious circle, but rather, how can it be stopped? More awareness of the actual values of automobiles would help.

Retail price stickers on the windows of new cars represent a fair mark-up over cost of the unit. All new-car agencies pay the same price for their cars from the factories. The dealer's selling price may vary depending on the season, his present stock, or his volume of sales, but no matter what his price to you is, he has to realize at least $200-300 profit from each car. If you manage to get him below this amount--watch out! Somewhere along the line, in service, or some after-sale item, he'll try to make it up.

Used-car wholesale and retail prices can be obtained from your banker. Remember, a used-car dealer is like every other businessman in that he has to buy wholesale and sell at retail in order to stay in business. Whether buying a new or used car, keep this in mind, and you're liable to be a more intelligent buyer and not alienate the dealer.

Most of the tricks to disguise a car's age or condition can be spotted by a sharp salesman. Heavy oil in the differential or transmission, regrooving the tires, turning back the odometer, body putty on caved-in panels that'll fall out in a week--and all the rest--are almost a thing of the past. Both car dealers and customers have tried them all, and have almost outgrown them.

Customers now do more attempted cheating with their words, rather than their actions. Misrepresenting themselves, their credit, their bank account, or any other thing which would tend to sway the dealer into giving them a better deal are becoming more common than a "phony" car. However it's done, most customers seem to feel that it is up to them to put on a one-man campaign to get the most for the least out of a car salesman-no matter how much deception is involved. Until this thought is erased from the minds of car buyers, salesmen and customers will remain wary of each other.

You can avoid many of the frustrations and confusions involved in automobile transactions. Inform yourself about car values, financial procedures, and the different kinds of guarantees offered by dealers. Know beforehand of his follow-up services and what you can expect from him. Let the car dealer make an honest buck in a legitimate deal, recognizing the fact that his main goal is to make a fair deal with the minimum of haggling. If you can't convince yourself of this, move on. Be completely satisfied that he and you are getting a fair deal, with no one being cheated.

Be as honest and frank with the dealer as possible. Stop gouging, and misrepresenting, and lying, and cheating. When he gets over the initial shock, he will probably give you the best deal you've ever had.

/MT

MOTOR TREND- June 1966- Vol. 18, No.6

FINANCING AND INSURANCE TIPS & TRAPS

"The old saying isn't necessarily true...Figures CAN lie."

Usury is defined as the maximum rate of interest permitted by law. The maximum rate varies in different states, but it's impossible to chart the maximums because there are so many other laws permitting variations. As examples, small loan acts permit interest rates of 30% in some states which allegedly have a maximum interest rate of 12%.

Have you ever wondered why dealers advertise "no payment for 45 days"? Most states have laws which permit an additional percent to be charged over and above the legal maximum if the first payment is not due for 45 days or more. The unsuspecting buyer gets 15 days of grace for which he pays 1% of the total contract price multiplied by the number of years the contract is in effect. On a $2000 balance, financed over a 36-month period, that extra 15-day period in which to make the first payment will cost you $60!

The average maximum interest rate is 10% on used-car paper, although a majority of states permit higher amounts. Banks and other lending institutions survive nicely on less than the maximum, and even in these days of fluctuating prime interest rates, it isn't unusual to see banks advertising car loans at 5%.

Lending institutions usually finance a percentage of the wholesale value of the car. You are paying a retail price, and the difference is usually your down payment. With good credit, you are a better risk, and therefore entitled to a lower interest rate. If your credit is bad, or has never been established, the lending institution charges an increased amount to compensate for the greater risk.

Be aware that most dealers have different-colored rate cards to display to the buyer who wishes to finance his purchase. Usually, a dealer opens his drawer and pulls out an orange card which, when carefully computed, should show the buyer that he is paying 10%. If he balks, the dealer might open the drawer and pull out a gray card, which is nothing more than a chart showing the monthly payments at 9%. Rest assured that the dealer also has green, blue, white, and red cards with interest computed at various percentages all the way down to 5%.

The dealer wants as much interest as the traffic will bear. You may wonder why, as interest is payable to the finance company or bank, but there is a reason. If he charges you 8% and the lending institution is willing to accept 6%, he gets a kick-back of 2% when you finish paying on the contract. That 2% on $2000 for a 2-year period is $80. On a 3-year contract, it is $120. Thus you see why the dealer so readily reduced the initial price of the car when you started to bargain.

Don't hesitate to be hard-nosed on the question of interest. Unless you are getting a low rate, demand a better deal. Before he lets you off the hook, the dealer will put out those other colored cars - he won't lose the deal because you insist upon a reasonable finance charge to which you are entitled in the first place.

All banks and dealers, but few buyers, know of another sneaker in the interest chart. If you owe $2000 on the mortgage on your home, your monthly payments include interest on existing principal. Therefore, each month, even though the payment is the same, more is applied to principal and less and less to interest. But the usual car loan involves straight interest. If you are paying 6% over a 2-year period, the 6% is computed on the original loan for the entire 24-month period. The difference is illustrated by the fact that $2000 on the mortgage is payable over a 2-year period at approximately $88 per month, while the same $2000 at the same 6% rate of interest on a car loan is payable at approximately $93 per month.

There are four main factors that govern interest. Prevailing interest rates are most important because if your neighbors are all paying 8%, it will be pretty difficult for you to finance at, say, 5%. Merchants usually try to increase their margin of profit, and the car dealer is no exception. If all dealers in a given city are writing 8% contracts, you will have a rough time bargaining for a lower rate. Nevertheless, argue for your rights--the dealer still may accept your deal.

Ignorance of the buyer is the second in importance, because a majority of buyers don't know that they are entitled to a lower rate. No one asks for something if he is not aware that it exists.

Credit rating of the buyer, if bad, is a legitimate reason for the dealer to raise the charges. And the amount of the loan compared to the value of the car is closely related to credit rating. If a lending institution has $1000 loaned on a car which is reasonably worth $2000, it will probably come out without loss in the event of a repossession. If, however, the lender has loaned $1900 on a $2000 car, it is an actuarial trouble, and will charge accordingly.

The dealer himself can cost or save you money, depending on his financial condition. When you sign your contract, it is usually assigned or sold by the dealer to a bank or lending institution. The dealer gets his money immediately, on the "futures" of your monthly payments. Most of these contracts are sold by the dealer to the money lender "with recourse." This means that if you default, the dealer will repay all amounts owing to the money lender on your behalf. Money lenders look into the financial condition of the dealer to make sure that the dealer can pay any losses if the car buyers default. If the dealer is himself shaky, the risk is passed on to the buyer in the form of a higher rate.

When it comes to the quoted interest rate, don't take the salesman's word. Do your own figuring, and you may be terribly surprised to find that you are being charged 10% even though the salesman said the rate was 6%.

Now you know that the purchase of a car includes much more than the cost of the car, and that you should pay as much cash as you safely can, financing the least possible amount. The more you finance, the more you pay in interest; the more you pay in interest, the more you pay for the car. The buyer who finances everything but 5% or 10% of the total cost really saves nothing by getting the dealer down a couple of hundred dollars in price.

Many buyers make an unfortunate mental mistake in cheerfully paying whatever rate of interest is offered under the assumption that interest is deductible for federal income tax purposes. Interest is deductible, but no deduction is as good as having the money in place of the deduction. If the dealer designates the carrying cost as interest, it is deductible, but many companies call it a "finance charge" or "service charge" or even "carrying charge" and Uncle Sam then takes a dim view of the deduction.

There usually isn't any problem with a bank. Banks are in business to make money, and they make money by collecting interest. But many finance companies don't like to use the word "interest" because a phrase like "carrying charge" is less scary. You may be deprived of a legitimate deduction simply because of the semantics in your finance contract.

If you negotiate a poor contract, the amount you pay for interest will exceed the combined cost of sales taxes, license fees and extras on the car. So, you see, finance charges are truly of interest to you.

FOR SURE, INSURE

Because it is so costly, insurance is a major consideration in the purchase of any car. During the life of a car, insurance will cost you more than the initial cost of extras plus your maintenance on the car. Insurance should be considered from two angles: insurance on the car to reimburse the owner (or dealer) in case of damage to the car, and insurance to protect the owner from liability in the event of an accident.

The dealer is primarily interested in selling you the type of insurance that covers damage to the car itself, generally known as "material damage" insurance. After all, if a car is wrecked, if you stop making payments, and if there is no insurance company to pay for repairing the car, the dealer would have to repossess a blob of twisted metal and attempt to recover the cost of repairs from you.

Not many dealers are also insurance agents or brokers. Those not directly in the insurance field may have a friend, cousin or brother whom they recommend to the buyer--or, more often, they smoothly ease you into buying a policy from the insurance subsidiary or associate of the finance company. For this, the dealer receives a commission in one form or another. Remember, you have every right to insist upon dealing with your own broker.

Frequently, a buyer recalls that he is paying some money for insurance and incorrectly assumes that he is completely covered. You have no idea how many people find out after an accident that they had no insurance for the other party. There is a difference, and the insurance to protect the other party is known as "public liability" insurance. Insurance to protect another party's car from damage is known as "property damage" insurance. These must be distinguished from "material damage" insurance, which is the only coverage the selling dealer can insist that you carry.

All too frequently, when public liability or property damage insurance is sold by the dealer, it is sold in incorrect amounts which do not nearly cover the driver's potential liability. More often than not, the car buyer gets $5000 property damage and $10,000 public liability limits. A broken leg these days is worth more than $10,000, and if you are unfortunate enough to cause a Standard Oil tanker or Park Ward Rolls-Royce to flip, the repairs can exceed $20,000. If you have a $5000 policy, the insurance company will pay the first $5000, and you will be stuck for the balance.

The cost for increased limits is absolutely negligible when compared to the initial cost of the basic policy. The absolute minimum for any driver should be $10,000 property damage and public liability coverage of $50,000 limit. Watch out for the cost, however, because even with proper limits, you may be stung financially. Keep reading and you will learn how.

The dealer, as mentioned, is interested in insuring the automobile, and his contract will have a clause providing that you will keep insurance on the car itself during the life of the contract. Insurance on the car is divided into different types of policies. We have mentioned the material damage policy. In addition to collision coverage, this usually includes fire, theft, and comprehensive. You will need all these coverages, and of course will have to pay for them.

The most costly type of collision insurance is known as full coverage. Under it, the insurance company will pay for even a $2 scratch in the paint, but if you make too many small claims, you will soon receive a notice of cancellation. The most popular insurance is known as $50 deductible. It costs less than full coverage, because you pay the first $50 for the repair of your car, and the insurance company pays the rest. A better type of insurance to have is $100 deductible or even $200 deductible. The premiums on these types are considerably less, and if you can afford to lay out the first $100 or $200 in the event of an accident, the law of averages will save you many dollars.

Most states have insurance commissioners-public officials who oversee the insurance business to keep it honest. Insurance commissioners generally establish a minimum rate for insurance, and it is a violation of law for an agent, broker or insurance company to sell insurance for less than the minimum rate. Very few states have laws establishing a maximum premium for a given policy, and while an insurance company cannot cut its price, it can charge whatever the traffic will bear. It is important to the used-car buyer to find out whether the price he is paying is, in fact, a competitive price, especially if the cost is added to his car payments. Many people have found, after they signed their contracts, that they were paying twice as much for the very same insurance as their neighbor.

If that used car is your second car, and its financial importance is not really large in your overall financial position, then you should be aware that there is a type of policy known as Vendor's Single Interest, referred to in the automotive trade as VSI. This type of insurance is very inexpensive and protects only the dealer's interest in the car. If you can afford to replace an inexpensive second car, by all means purchase VSI, because it does fulfill the contract requirements of insurance at all times during the existence of the contract.

Most fire, theft and comprehensive policies contain an "ACV" clause. In the event of a loss, the insurance company is liable only for the actual cash value of the car, and actual cash value may be a lot less than the car is worth to you or than you paid for it. Generally, in the event of loss, the company will pay you the then existing wholesale value of your car, but you cannot go out and replace it with the money because you are buying from a retailer. To protect yourself against this, at a minimum increased cost, purchase a fire, theft and comprehensive policy with a "stated value" clause. Under this type of coverage, you and the insurance company agree on the value of your car, and in the event of a loss, the insurance company pays you the stated value.

If the newly acquired jalopy is a second or third car in a family which has less than one driver for each automobile owned, many dollars can be saved by purchasing insurance policies with an endorsement known as a "more cars than operators endorsement." If one person owns two cars and is the only driver of the car, he is entitled to this endorsement, which will save him almost 75% of the total cost of public liability and property damage coverage on the second car. The drawback is that if another person should happen to have an accident while driving one of your cars, the insurance company can get off the hook by saying that under the "more cars than operators" endorsement, no one was supposed to drive the car except the insured party.

Insurance is the greatest thing in the world for ease of mind if you are at fault and cause an accident. Assuming that the limits exceed the amount of damage, the company defends, pays all court costs and legal fees, and you have nothing much more to do than cooperate with the company and possibly appear to testify at a trial or deposition. That word "cooperate" is an important one, because failure to cooperate with the company will nullify the liability of the company. Failure to report an accident within a reasonable time will also let the company off the hook.

The picture isn't nearly as rosy, however, if the accident is caused by the negligence of another person and it is your car that is damaged.

Insurance companies are becoming harder and harder to deal with, claiming their losses are excessive in the automotive field. Let's assume that you are stopped at a signal and someone rams the rear of your car. You have the damage appraised by three different, reputable garages, and all the estimates are around $400. When you file your claim with the other party's insurance company, an adjuster inspects your car and offers you $250 cash in full settlement. Appalled, you argue that the damage is actually $400, but to no avail.

You can sue, but depending on locality, it may take you anywhere from three months to three years to get into court, and attorney's fees may run as high as $250. During that period, the car may not be operable, or if it is, you may be obliged to drive it in a damaged condition.

You may have no recourse except to claim physical injury--in which case the insurance company will probably settle promptly for the full $400 in order to get a release of your injury claim. This practice is morally reprehensible and an equally vicious part of the cycle as the insurance company's reneging on its real obligations in the first place.

Amos and Andy used to tell a famous joke to the effect that the big print giveth and the small print taketh away. While they made a joke of it, nothing could be more factual from a legal standpoint. Read -- and understand -- your policy before paying for it. Realize that an insurance policy is an agreement, and that all policies are not similar. For example, some companies will pay for the value of a car which is stolen if it has not been recovered in 30 days. Other companies won't pay for 90 days or longer.

When you shop for a used car, you are, in effect, comparing value to be received in relationship to cost. You should do the same with insurance contracts. The used-car buyer will rarely purchase the very first car he looks at, but that same buyer often accepts the very first insurance policy handed to him. It is senseless to buy wisely during the first part of the transaction and to act foolishly during the latter part. Your best bet is to deal only with a broker whom you know and trust.

Robert Gottlieb

MOTOR TREND - June 1966 - Vol. 18, No.6

USED CAR CHECK LIST

Fill out this top portion at home before starting to shop--then take list with you to car lots.

Honest, maximum amount you can spend

Cash $\_\_\_\_\_\_\_\_\_\_Finance--$/mo $__________

Down payment $__________

Remember to include taxes, estimated finance charges, license and insurance

Desired model (classified ads will give idea of price spread)

	Make	Year	Body style	Color
1st choice				
2nd choice				
3rd choice				

After studying these ads, which dealers impress you?

Name	Address	New-car dealer?	Make

(Remember that a Ford dealer will have largest selection of Fords; a Plymouth dealer, Plymouths, etc. Also, that a make-for-make trade usually means satisfactory performance by your potential used car in the hands of its 1st owner.)

Do you have a trade-in?

Study ads again for what your car will bring. Deduct 25% for the difference between the retail and wholesale figure. Clean your car up yourself, if you wish, but don't pay to have this done. The dealer allows for this on his trade-in offer, but he pays on a downtime basis, whereas you would pay at retail. For this reason, never have bodywork repaired.

Condition of Car: If all the left-handed boxes are checked, you've found yourself a creampuff.

Recorded mileage________________

Factory warranty remaining________and/or________ miles

If none, dealer warranty offered

__________ % discount __________ months and/or __________ miles

Bodywork

Rust ( ) none ( ) repaired ( ) visible ________ $ estimate to fix

Chrome ( ) intact ( ) pitted ( ) missing ________ $ estimate

Damage ( ) none ( ) suspected ( ) visible ________ $estimate

Paint ( ) original ( ) repaint ( ) retouched ________ $ estimate

Tires

Type ( ) matched new ( ) worn matched ( ) mixed ( ) retreads

Engine

Type* ( ) std. V-8 ( ) big V-8 ( ) 6

Appearance ( ) refinished ( ) undisturbed ( ) greasy

*Large V-8 nomrally requires premium gas, gives much less mileage.

Radiator ( ) old, clean ( ) refinished ( ) new ( ) evidence of boil ( ) dented, leaky

Battery & assessories

( ) new ( ) fair wear ( ) need replacement

Interior

Upholstery

( ) clean ( ) seat covers? ( ) faded ( ) mixed new and old

Driver's door handles

( ) firm ( ) sloppy

Driver's side glass & vent

( ) firm ( ) loose

Windshield

( ) tinted ( ) clear ( ) traced by wipers ( ) scratched by wipers

Instruments

( ) complete ( ) radio removed ( ) no heater ( ) drilled panel (taxi)

Mats & pedals

( ) reasonable wear ( ) worn ( ) brand-new

USED CAR CHECK LIST
(continued)

Underbody (with car on rack)

Chassis (check 2) ( ) under-coated ( ) normal road dirt ( ) dirt and rust ( ) oil spray ( ) fresh welds

Brakes
( ) new wheel cylinders ( ) undisturbed dirt ( ) leakage ( ) % lining remaining

Engine
( ) undisturbed dirt ( ) oil seepage

Transmission
( ) undisturbed dirt ( ) oil seepage

Drive train
( ) solid ( ) loose universals ( ) loose front end ( ) axle bearing noise

Exhaust system

Type ( ) single ( ) dual ( ) non-stock
Condition
( ) new ( ) whole ( ) rusty ( ) leaking

Road Test
Ignition & key ( ) fair wear ( ) sloppy
Easy start ( ) instant ( ) hesitant ( ) labored ( ) weak battery
Smoke ( ) none ( ) black (rich mixture) ( ) moderate blue (oil) ( ) heavy blue (oil)

Warm-up ( ) fast, smooth ( ) hesitant
Transmission
(after warm-up)
( ) smooth & silent ( ) slips (automatic) ( ) noisy (standard)
Engine
(after warm-up)
(Check 2)
( ) smooth & silent ( ) constant oil pressure ( ) ping? ( ) light clatter ( ) heavy clatter

Rear axle (after warm-up) ( ) quiet ( ) noisy

Brakes ( ) silent, high pedal ( ) low pedal ( ) erratic ( ) noisy

Steering (check 2)
( ) firm ( ) no wander ( ) wanders ( ) loose

Suspension
( ) good control ( ) rebound ( ) harsh

Accessory Check List	Essential (for resale)	Desirable	Non-essential
V-8 engine	( )		
Automatic transmission	( )		
4-speed or overdrive		( )	
Heater	( )		
Radio	( )		
Mid-line model or better	( )		
Power steering	( )		
Power brakes		( )	
Power seats		( )	
Power windows			( )
Air conditioning		( )	
Automatic headlight dimmer			( )
Cruise-control			( )
Stereo		( )	
Limited-slip differential		( )	

Purchase

Actual final price plus taxes and license $______
Less down payment or trade ______
Add total finance charge (6% per month equals 12% per annum or original balance, etc.) ______
Add all insurance and other charges paid to dealer ______
Check "Book" price
(Car plus charges and down payment should not exceed retail "Book" figure) ______

Questions to Hottest Cars on the Lot

1. What type of used car dealer gives the greatest sense of trust to a potential buyer?
2. Name some reasons why people will trust a new car dealer who sells used cars?
3. Name one used car blessed with a continuing popularity?
4. What used cars were reported as the best sellers by car dealers?
5. Why do Chevy buyers prefer 2-door hardtops and Chrsyler shoppers prefer 4-door models?
6. How old were the best selling cars?
7. Why is this so?
8. What are four accessories that almost all dealers agree are desirable on a used car?
9. What is the most important item that consumers consider when determining the value of a used car?
10. Why does the new car dealer who sells a used car especially want the customer to be happy with his purchase?

Questions to Depreciation Works Two-Ways

1. What is the biggest single expense of car ownership?
2. What is significant about depreciation prices on specific car models?
3. Generally if a person wants to trade frequently, his best buy is the car that depreciates________________?
4. Generally if a person keeps the car for an extended period, choose the model with a ________________ rate of depreciation?
5. For what reasons are the above conclusions considered valid?

Questions to How To Spot a Lemon

1. From what type of dealer is it best to buy a used car?
2. For what reasons might one car dealer be considered more trustworthy than another car dealer?
3. What is the reasoning behind buying a used Dodge from a new - Dodge dealer?
4. What about a dealer can be discovered by looking at his advertisements?
5. Why should a dealer's facilities be investigated?
6. According to the article what is one way for a customer to judge the honesty of a salesman?

Exterior

1. What is one method used to judge if a car has been in an accident?
2. Where is the source of rust on the exterior of a car?
3. How can rust be hidden?
4. What is the tell-tail detection for hand-hammered panel?
5. State a quick check method for the possibility of a repaint job?
6. What do the bolts attaching the bumper to the car reveal?
7. What area is the hardest of all for bodymen to restore to original factory configuration?
8. What can a door handle reveal?

Interior

1. Why is an odometer mileage meaningless?
2. Surprisingly, what indicates mileage better than the odometer?
3. What part of the reconditioned car is often overlooked?
4. Of what material is the rear packaged deck composed?
5. Where is the first place to check for wear and tear on a convertible top?

Chassis

1. How is a chassis inspected?
2. How can new welding be spotted?
3. In what different ways should tires match?
4. What do retreads indicate?
5. What hints do front tires give?

Power Train

1. What does excessive oil on the underside of the car indicate?
2. What is an indication of a badly worn engine?
3. What is an indication of worn universal joints?
4. Why should the tires be rotated on their axles?
5. What is the one adequate means of testing an engine?
6. What do uneven readings on the cylinders reveal?

Road Testing

1. What color should the smoke fumes be?
2. How can inadequate oil pressure be checked if the car is equipped with warning lights?
3. What other gauge should be checked besides the oil pressure gauge?
4. What are some indications of poor brakes?
5. What is the problem if there is excessive rebounding of the car?
6. What new type of facility is available for spotting car troubles?

Questions to Can You Really Fool a Salesman?

1. What is the basic creed of people taking their cars to a used car dealer?

2. What is the most common way that a potential buyer is able to get a lower price for his new car?

3. What are some expenses of used car dealers?

4. Why would a customer demand immediate delivery?

5. How can an immediate delivery hold disadvantages for the buyer?

6. In order to make the dealer stand behind what he says, on what should the customer insist?

7. What does the buyer immediately consider after the salesman has quoted a price?

8. How much profit does a dealer with to realize on a new car?

9. What disadvantage is there if the dealer's profit is below his desired figure?

10. Since many car buyers have become too sophisticated to superficially improve the cars they wish to trade-in, how else do they attempt to deceive dealers?

11. What advice does the article give to the customer to help him avoid the frustration and confusion in an automobile transaction?

Questions to Financing + Insurance - Tips + Traps

1. Define usury?

2. Why do dealers allow up to forty-five days for the first car payment?

3. What is the average maximum interest rate on used cars?

4. How can a car buyer achieve lower interest rates?

5. What leeway does a dealer have with interest rates?

6. What advantage is it to the dealer to state higher interest rates?

7. What are four main factors that govern interest rates?

8. What are two protective safety features of insurance?

9. Why is the dealer concerned with material insurance for the car?

10. For what other reason does the car dealer desire to sell insurance for the car?

(continued)

11. What are some reasons for going to a professional insurance man for car insurance?

12. Why should a buyer be apprehensive about car insurance salesmen who give cut-rate deals?

13. Why is $50 deductible collision insurance cheaper than full coverage?

14. What is the advantage of a "stated value" clause in an insurance policy?

15. What is the important point that the author of the insurance articles states at the conclusion?

Projects

1. Have a speaker from the local Better Business Bureau or bank talk to the class on the credit industry.

2. Have the students visit some local banks to find out what their procedures are for lending money. Find Out:

   a. What types of loans are made?
   b. What amount of money is the bank willing to extend on a loan?
   c. What type of person is the bank willing to extend a loan to?
   d. What is bank's rate of interest?
   e. What is the true rate of interest?
   f. How does the bank decide on an interest rate?
   g. What use is made of the local Credit Bureau?
   h. What is the manner of collecting on a loan?
   i. What happens if a person falls behind in his loan payments?
   j. What does the bank do on defaults?
   k. When does the bank repossess an item?
   l. How does the bank repossess the item?
   m. What jobs are available in the credit field?
   n. How much of the banks's business is based on consumer loans?

3. Have the students visit the local shopping centers and take a look at their credit procedures. Some questions are:

   a. How easy is it to open a charge account?
   b. What criteria is used for judging a person who wishes to open a charge account?
   c. What arrangements are made for repayment?
   d. How much interest is charged on a charge account?
   e. How are repayments collected?
   f. What happens if a person falls behind in his loan payments?
   g. How are defaults handled?
   h. How are repossessions handled?
   i. What jobs are abailable in the credit field?
   j. What use is made of the local credit bureau?
   k. What amount of the store's business is done on credit?

4. Have students chart the rates of various lending institutions.

5. Compare the newspaper advertisement prices of a high priced item bought for cash to what the item would cost if it were bought on credit.

Junior Year

Industrial Prep English
Unit Five

Prejudice

I. Background

II. Projection

III. Literature and Prejudice
   A. South Pacific
   B. The Teahouse of the August Moon
   C. To Sir, With Love
   D. Negro Poetry

IV. Prejudice and the Mass Media

V. Projects

Prejudice Unit
Background

I. Definition

- A. A prejudgement
- B. Little or no facts
- C. Stereotype
  - 1. oversimplified
  - 2. exaggerated
  - 3. ridiculous

II. Causes

- A. External (Environment)
  - 1. home
  - 2. school
  - 3. friends
  - 4. television
  - 5. motion pictures
  - 6. books
  - 7. newspapers

- B. Internal
  - 1. self-interest (economic)
  - 2. conservatism (habit)
  - 3. radicalism (change)
  - 4. conventionality

III. Patterns - Why?

- A. North-Puerto Rican
- B. South-Negro
- C. Pacific West-Oriental
- D. Southwest-Mexican
- E. Northwest-Indian
- F. South Africa-Negro
- G. England-Indian (India)

IV. Organized Prejudice

- A. Scapegoat
- B. KKK
- C. Certain radical and reactionary groups

V. Effects of Discrimination

- A. Jobs
- B. Civil Rights
- C. Political Rights
- D. Housing
- E. Education

VI. Negro Reaction

A. Organizations

1. National Association for the Advancement of Colored People (N.A.A.C.P.)
2. The National Urban League
3. Congress of Racial Equality (C.O.R.E.)
4. Southern Christian Leadership Conference (S.C.L.C.)
5. The Student Nonviolent Coordinating Committee (S.N.C.C.)

B. Progress

VII. Intergroup Relations

Projection

I. Theory-Misunderstandings arise when we project our feelings to others. We are projecting our feelings when we speak or act as if our inside feelings were real things in the outside world.

A. Examples
1. Mr. Jones dislikes female students.
2. Mickey Mantle is finished as a ballplayer.
3. Opera is boring.

B. Definition of Projection
1. to send forth
2. motion picture screen

II. Experiments

A. Ink Blots-Students project their feelings on to ink blots.

B. Rumor Clinic of the Anti-Defamation League. Students see how rumors are spread.

C. "The Man Behind the Door"
1. Tell students there is a man sitting behind a door. What are their feelings toward that man?
2. Tell them that the man is a Negro. Now what are their feelings towards the man?
3. Have them compare their feelings before they knew he was Negro and after they found out he was Negro.

D. Man in car behind you honks his horn.--Immediately a number of possibilities are suggested for his horn blowing.

E. People project their fear of snakes or the dark.

III. Why should we guard ourselves when projecting?

A. Fear
B. Suspicion
C. Hatred
D. Prejudice

Carefully Taught from South Pacific

by Richard Rodger & Oscar
Hammerstein II

You've got to be taught to hate and fear.
You've got to be taught from year to year
It's got to be drummed in your dear little ear;
You've got to be carefully taught.

You've got to be taught to be afraid,
Of people whose eyes are oddly made,
And people whose skin is a different shade;-
You've got to be carefully taught.

You've got to be taught before its too late.
Before you are six or seven or eight.
To hate all people your relatives hate,
You've got to be carefully taught.
You've got to be carefully taught.

The tragic subplot of South Pacific is the romance of Lt. Joseph Cable and the Tonkenese girl, Liat. They sincerely love each other, but Cable correctly fears that the difference in their races would work against a happy marriage for them. In Carefully Taught he explains the origin of prejudice in human beings.

1. Are human beings actually taught to hate and fear?
2. Who does Lt. Cable feel is doing the teaching?
3. Where do human hates and prejudices come from?
4. Are human beings born with hates or prejudices?
5. Do we tend to reflect the feelings of our relatives and friends on issues of race or religious prejudice?
6. Why does the song say that these teachings must be done "before you are six or seven or eight"?
7. Does Lt. Cable believe that people actually teach their chidren to hate and fear?

Sakini's Observations from *The Teahouse of the August Moon*

by John Patrick

Lovely ladies, kind gentlemen:
Please to introduce myself.
Sakini by name.
Interpreter by profession.
Education by ancient dictionary.
Okinawan by whim of gods.
History of Okinawa reveal distinguished
    record of conquerors.
We have honor to be subjugated in fourteenth
    century by Chinese pirates.
In sixteenth century by English missionaries.
In eighteenth century by Japanese war lords.
And in twentieth century by American Marines.
Okinawa very fortunate.

Culture brought to us...Not have to leave
    home for it.
Learn many things.
Most important that rest of world not like
    Okinawa.
World filled with delighful variation.
Illustration.
In Okinawa...no locks on doors.
Bad manners not to trust neighbors.
In America...lock and key big industry.
Conclusion?
Bad manners good business.
In Okinawa...wash self in public bath with
    nude lady quite proper.
Picture of nude lady in private home...quite
    improper.
In America...statue of nude lady in park
    win prize.
But nude lady in flesh in park win penalty.
Conclusion?
Pornography question of geography.

But Okinawans most eager to be educated by
    conquerors.
Deep desire to improve friction.
Not easy to learn.
Sometimes painful.
But pain makes man think.
Thought makes man wise.
Wisdom makes life endurable.

Sakini's Observations attempt to treat humorously the kinds of things that happen when two different cultures meet.

1. Sakini remarks that the History of Okinawa reveals a distinguished record of conquests and that they have had the honor to be subjugated by many people. What does he mean by the words "distinguished" or "honor"?

2. Sakini says that the U.S. Marines "subjugated" the Okinawans. The U.S. Government would probably say that the Marines "occupied" Okinawa. Is there any difference in the words "subjugated" and "occupied"?

3. What was the most important thing that Okinawa learned from the rest of the world?

4. Sakini observes that Okinawans trust their neighbors for they leave their doors unlocked. In America doors are kept locked. His conclusion is that Americans do not trust their neighbors. Is he correct? Which culture shows a higher degree of ivilization, Okinawan or American?

5. According to Sakini, is the American or Okinawan approach to pornography correct? Is any approach correct?

6. How does Sakini feel that the two cultures can reduce conflict?

Prejudicial Issue

To Sir, With Love
by E. R. Braithwaite

1. For what reasons did the woman on the bus not sit next to Braithwaite?

2. Even though Braithwaite is well-prepared for a job, what reasons do the people give for not hiring him?

3. From what group do you think the hiring procedures emanated?
   a) the employers? b) the employees? c) the personnel departments? d) the unions? e) no one in particular?

4. Why was prejudice forgotten during the war?

5. Why would the British nation think there was no racial problem?

6. What stereotype statements are made throughout the book?

7. What is the difference in the prejudice attitude between the U.S.A. and Britain? between the North and the South? between California and New York?

8. Why do you think that the people are not willing to trust Braithwaite with machines, but are willing to let him educate their children?

9. Why is Braithwaite one of the few Negro teachers in Britain?

10. Don't we find that certain groups tend to veer toward particular industries, professions, and fields? For instance what group is prominent in the sport of Boxing? How many non-white pro-golfers are there? What is the religious affiliation of most barbers?

10 A--At the cost of stereotyping, does it appear that in the U.S. certain religions, ethnic and racial groups are prominent in certain fields?

11. State some of Weston's stereotype statements and the reasons for them?

12. What type of stereotyping is evident on the train when the class is on a field trip?

13. How does the Globetrotters field trip show how the mass media have contributed to the stereotyping of the U.S. Negro?

14. How should Braithwaite have reacted to the waiter in the restaurant?

15. Why is Gillian hurt more than Braithwaite over the incident?

16. The students have appeared to learn much from Braithwaite about prejudice, but why do they initially react the way they do upon hearing of Seales' mother's death and of Braithwaite's suggestion of the wreath?

17. Does this reaction show that the kids are phonies?

18. Would you say that in general the U.S. white middle-class is phony in their desire to eradicate prejudice?

19. Could Gillian and Braithwaite really overcome the problems that their marriage would create?

20. How does Braithwaite show his students that interracial unity in their community is a possibility?

Negro Poetry

What Happens To A Dream Deferred?
by Langston Hughes

What happens to a dream deferred?
Does it dry up
Like a raisin in the sun?
Or fester like a sore--
And then run?
Does it stink like rotten meat?
Or crust and sugar over--
Like a syrupy sweet?

Maybe it just sags
Like a heavy load.

Or does it explode?

1. What use do you make of your five senses when reading the poem?
2. What is a definition for the phrase "a dream deferred"?
3. Give some examples of "dreams deferred"?
4. There are six questions and one statement in the poem, what does the one statement do?
5. What is the poet's primary question?
6. Is the poet's primary question ever answered?
7. Why should the poet write about "a dream deferred"?

DREAMS
by Langston Hughes

Hold fast to dreams
for if dreams die
Life is a broken-winged bird
That can not fly.

Hold fast to dreams
For when dreams go
Life is a barren field
Frozen with snow.

Questions

1. What is the poet's comparison in Stanza I?
2. What are the emotions that the comparison expresses?
3. What is the comparison in Stanza II?
4. What are the emotions that the comparison expresses?
5. Why has the poet chosen to express these emotions?

MOTHER TO SON

by Langston Hughes

Well, son, I'll tell you:
Life for me ain't been no crystal stair.
It's had tacks in it,
And splinters,
And boards torn up,
And places with no carpet on the floor--

But all the time
I'se been a-climbin' on,
And reachin' landin's,
And turnin' corners
And sometimes goin' in the dark
When there ain't no light.

So, boy, don't you turn back.
Don't you set down on the steps
'Cause you find it's kinder hard.
Don't you fall now--
For I'se still goin', honey,
I'se still climbin'
And life for me ain't been no crystal stair.

Questions

1. What type of person is the mother?
2. What is characteristic of her language?
3. What does her language tell us about her?
4. From where does the women draw her advice?
5. Does the mother hold any hope for herself? Why?
6. How did the mother get these ideals in the first place?
7. Do you think the son will profit from this advice? Why or why not?

Brass Spittoons

by Langston Hughes

Clean the spittoons, boy.
    Detroit,
    Chicago,
    Atlantic City,
    Palm Beach.
Clean the spittoons,
The steam in hotel kitchens,
And the smoke in hotel lobbies,
And the slime in hotel spittoons:
Part of my life.
    Hey, boy!
    A nickel,
    A dime,
    A dollar,
Two dollars a day.
    Hey, boy!
    A nickel,
    A dime,
    A dollar,
    Two dollars
Buys shoes for the baby.
House rent to pay.
Church on Sunday.
    My God!

Babies and church
and women and Sunday
all mixed up with dimes and
dollars and clean spittoons
and house rent to pay.
    Hey, boy!

A bright bowl of brass is beautiful to the Lord.
Bright polished brass like the cymbals
Of King David's dancers,
Like the wine cups of Solomon.
    Hey, boy!
A clean spittoon on the altar of the Lord.
A clean bright spittoon all newly polished,
At least I can offer that.
    Com'mere, boy!

1. Why did the poet chose this type of job for the narrator of the poem?
2. What do the four cities indicate?
3. What is the narrator called by the people?
4. Why has the narrator chosen this type of job?
5. How do we know the narrator is a man and not a teenager?
6. In the last stanza to what is the spittoon compared? Why?
7. What are the feelings of the narrator who polishes the spittoons?
8. What can be said about the date of this poem?
9. Would such a poem be written today? Why?

I, TOO, SING AMERICA

by Langston Hughes

I, too, sing America.

I am the darker brother.
They send me to eat in the kitchen
When company comes,
But I laugh,
And eat well,
And grow strong.

Tomorrow,
I'll sit at the table
When company comes.
Nobody'll dare
Say to me,
"Eat in the kitchen,"
Then.

Besides,
They'll see how beautiful I am
And be ashamed--

I, too, am America.

DREAM VARIATION

by Langston Hughes

To fling my arms wide
In some place of the sun,
To whirl and to dance
Till the white day is done.

Then rest at cool evening
Beneath a tall tree
While night comes on gently,
Dark like me--
That is my dream!

To fling my arms wide
In the face of the sun,
Dance! whirl! whirl!
Till the quick day is done.
Rest at pale evening....
A tall, slim tree....
Night coming tenderly
Black like me.

CROSS

by Langston Hughes

My old man's a white old man
And my old mother's black.
If ever I cursed my white old man
I take my curses back.

If ever I cursed my black old mother
And wished she were in hell,
I'm sorry for that evil wish
And now I wish her well.

My old man died in a fine big house,
My ma died in a shack.
I wonder where I'm gonna die,
Being neither white nor black?

SONG FOR A DARK GIRL

by Langston Hughes

Way Down South in Dixie
  (Break the heart of me)
They hung my dark young lover
  To a cross roads tree.

Way Down South in Dixie
  (Bruised body high in air)
I asked the white Lord Jesus
  What was the use of prayer.

Way Down South in Dixie
  (Break the heart of me)
Love is a naked shadow
  On a gnarled and naked tree.

THE WOUNDED PERSON

From Song of Myself

by Walt Whitman

The hounded slave that flags in the race, leans by the fence,
    blowing, cover'd with sweat,
The twinges that sting like needles his legs and neck; the
    murderous buckshot and the bullets,
All these I feel or am.

I am the hounded slave, I wince at the bite of the dogs,
Hell and despair are upon me, crack and again crack the marksmen,
I clutch the rails of the fence, my gore dribs, thinn'd with
    the ooze of my skin,
I fall on the weeds and stones,
The riders spur their unwilling horses, haul close,
Taunt my dizzy ears and beat me violently over the head with
    whipstocks.
Agonies are one of my changes of garments.
I do not ask the wounded person how he feels, I myself become
    the wounded person.

THE CREATION

by James Weldon Johnson

And God stepped out on space,
And He looked around and said:
I'm lonely--
I'll make me a world.

And far as the eye of God could see
Darkness covered everything,
Blacker than a hundred midnights
Down in a cypress swamp.

Then God smiled,
And the light broke,
And the darkness rolled up on one side,
And the light stood shining on the other,
And God said: That's good!

Then God reached out and took the light in His hands,
And God rolled the light around in His hands
Until He made the sun;
And He set that sun a-blazing in the heavens.
And the light that was left from making the sun
God gathered it up in a shining ball
And flung it against the darkness,
Spangling the night with the moon and stars.
Then down between
The darkness and the light
He hurled the world;
And God said: That's good!

Then God himself stepped down--
And the sun was on His right hand,
And the moon was on His left;
The stars were clustered about His head,
And the earth was under His feet.
And God walked, and where He trod
His footsteps hollowed the valleys out
And bulged the mountains up.

Then He stopped and looked and saw
That the earth was hot and barren.
So God stepped over the edge of the world
And he spat out the seven seas--
He batted His eyes, and the lightning flashed--
He clapped His hands, and the thunders rolled--
And the waters above the earth came down,
The cooling waters came down.

Then the green grass sprouted,
And the little red flowers blossomed,
The pine tree pointed his finger to the sky,
And the oak spread out his arms,
The lakes cuddled down in the hollows of the ground,
And the rivers ran down to the sea;
And God smiled again,
And the rainbow appeared,
And curled itself around His shoulder.

Then God raised His arm and He waved His hand
Over the sea and over the land,
And He said: Bring forth! Bring forth!
And quicker than God could drop His hand,
Fishes and fowls
And beasts and birds
Swam the rivers and the seas,
Roamed the forests and the woods,
And split the air with their wings.
And God said: That's good!

Then God walked around,
And God looked around
On all that He had made.
He looked at His sun,
And He looked at His moon,
And He looked at His little stars;
He looked on His world
With all its living things,
And God said: I'm lonely still.

Then God sat down--
On the side of a hill where He could think;
By a deep, wide river He sat down;
With His head in His hands,
God thought and thought,
Till He thought: I'll make me a man!

Up from the bed of the river
God scooped the clay;
And by the bank of the river
He kneeled Him down;
And there the great God Almighty
Who lit the sun and fixed it in the sky,
Who flung the stars to the most far corner of the night,
Who rounded the earth in the middle of His hand,
This Great God,
Like a mammy bending over her baby,
Kneeled down in the dust
Toiling over a lump of clay
Till He shaped it in His own image;

Then into it He blew the breath of life,
And man became a living soul.
Amen. Amen.

Prejudice and the Mass Media

Here are some general evaluative questions to be used when reading, viewing or listening to any of the mass media.

I. Style

A. Are some of the characters in the mass media depicted as inferior?

B. What are some of the necessary qualifications for a person to be termed as inferior?

C. Is the book or film propagandistic or artistic?

D. Is the book or film constructive or destructive in its treatment of the racial problem?

E. Why do writers resort to stereotyping in the mass media?

F. Would you say that the mass media distort reality and create illusion about the racial problem?

G. Would you say that the mass media are responsible for creating many prejudices?

H. What responsibility does the mass media have toward the racial problem?

II. Acting

A. Why aren't there more Negro actors in television and films?

B. Do the Negro actors in television and films play strictly Negro parts?

C. How many Negro actors can you name who play roles that any actor can portray?

D. Have you noticed many Negroes in advertisements?

E. Why has it taken so long for Negroes to make it into the acting phase of show business?

Sample List of Material for the Prejudice Unit

BOOKS

1. *To Kill A Mockingbird* --Harper Lee
2. *A Raisin in the Sun*--Lorraine Hansberry
3. *To Sir, With Love*--E.R. Braithwaite
4. *Black Like Me*--John Howard Griffin

FILMS

1. *Home of the Brave*
2. *Black Like Me*
3. *A Patch of Blue*

TELEVISION SHOWS

1. *I SPY*
2. *Mission Impossible*
3. CBS Playhouse - *The Final War of Olly Winter* by Ronald Ribman.

c SHORT STORIES --*Stories for Youth* - ed. Lass & Horowitz

1. That Greek Dog by Mackinlay Kantor
2. The Test by Angelica Gibbs
3. The Stepmother by Margaret Weymouth Jackson

Projects

1. Have each student note all the prejudicial expressions regarding racial, religious, ethnic, and age issues that they have heard in the last twenty-four hours. Read each list to the class without indicating who compiled each list. Can the class select who wrote each list?

2. Students stand outside a large housing development or apartment house. They note the number of Negro and White people entering and leaving; also noting, if possible, whether they live or work there. Can any conclusions be made from these observations?

3. Attempt to obtain some statistics of the numbers and races of people who have been executed for U.S. crimes in previous years and of those people who await execution in this current year. What conclusions, if any can be made from these facts?

4. Make a list of religious and ethnic backgrounds of students in a number of classes. See if any conclusions can be drawn as to:

   a) the courses of study that certain groups of people choose.

   b) the towns or sections that certain groups of people come from?

   c) the elective subjects that certain groups of people choose?

If there are definite trends have the class speculate as to why these trends exist.

Bibliography

I. Bradbury, Ray; Fahrenheit 451, Ballantine Books, N.Y. 1953

Braithwaite, E.R.; To Sir, With Love, Pyramid Books, N.Y. 1959

Corbin, Richard K. & Perrin, Porter G; Guide To Modern English, For Grade Eleven, Scott Foresman & Co., Fair Lawn, N.J., 1963

Hohn, Max T.; editor, Stories In Verse, The Odyssey Press, N.Y., 1961

Hughes, Langston & Bontemps, Arna; editors, The Poetry of the Negro, Doubleday & Co., Inc., Garden City, N.Y., 1949

Lass, A.H. & Horowitz, Arnold; editors, Stories for Youth, McGraw-Hill Book Co., Inc., N.Y.

Minteer, Catherine; Words & What They Do To You, Row, Peterson & Co., White Plains, N.Y., 1953

Postman, Neil, Morine, Harold & Morine, Greta; Discovering Your Language, Holt, Rinehart & Winston, Inc., N.Y. 1963

Postman, Neil; Exploring Your Language, Holt, Rinehart & Winston, Inc., N.Y., 1966

Postman, Neil & Damon, Howard C.; The Languages of Discovery Holt, Rinehart & Winston, Inc., N.Y., 1965

Postman, Neil; Language & Reality, Holt, Rinehart & Winston, Inc., N.Y. 1966

Postman, Neil & Damon, Howard C.; Language & Systems, Holt, Rinehart & Winston, Inc., N.Y., 1965

Postman, Neil; Television and The Teaching of English, Appleton - Century - Crofts, Inc., N.Y. 1961

Postman, Neil & Damon, Howard C.; The Uses of Language, Holt, Rinehart & Winston, Inc., N.Y. 1965

Rakow, Edwin; editor, Lyric Verse, The Odyssey Press, N.Y., 1962

Sankowsky, S.; Sociology for High School, Oxford Book Co., N.Y., 1967

Sypherd, W.O.; Fountain, Alvin M., Gibbens, V.E.; Manual of Technical Writing, Scott Foresman & Co., Fair Lawn, N.J., 1957

Untermeyer, Louis; editor, *Modern American & British Poetry*, Harcourt, Brace & Co, N.Y. 1950

Ward, Herman M.; *Poems for Pleasure*, Hill & Wang, N.Y., 1963

Wilhelms, Heimerl & Jelley; *Consumer Economics*, McGraw-Hill Book Co., N.Y., 1966

Periodical

1. *Motor Trend*; June 1966, Vol.18, No.6